

MEMOIRS
OF THE
NATIONAL MUSEUM
OF VICTORIA
MELBOURNE

(World List abbrev. Mem. Nat. Mus. Vic.)

No. 16

Issued December, 1949

R. T. M. PESCOTT, M.Agr.Sc., F.R.E.S.
DIRECTOR

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BROWN, PRIOR, ANDERSON PTY. LTD., 430 LITTLE BOURKE ST., MELBOURNE, C.1

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NEW PEDIPALPI FROM AUSTRALIA AND THE SOLOMON ISLANDS

By R. A. Dunn,

Honorary Arachnologist, National Museum of Victoria.

Figs. 1-6.

(Received for publication September 29, 1948.)

This paper deals principally with two new whip-scorpions. Of these, the one described hereunder as *Charinus pescotti* sp. nov. is recorded from Australia and the Solomon Islands, and is but the second species of the order to be reported from Australia. The statement by Werner (1935, p. 475) that "Australien (Festland) enthält keine einzige Gattung und Art" is erroneous, inasmuch as the ill-defined *Charon annulipes* Lauterer had been described from Brisbane, Queensland, many years previously.

The other species dealt with, namely *Stygophrynus* (*Neocharon*) *forsteri* subgen. et sp. nov., is from the Solomon Islands, and seems to be sufficiently distinctive to warrant separation from the more typical congeners.

Order PEDIPALPI

Suborder AMBLYPYGI

Family TARANTULIDAE

Subfamily Charontinae

Genus CHARINUS Simon, 1892

SYNOPSIS OF SPECIES

- | | |
|--|--|
| 1. Finger with one dorsal spine. | <i>C. jeanneli</i> Simon. |
| - Finger with two dorsal spines. | 2. |
| - Finger with three dorsal spines. | 5. |
| 2. Spines of finger small and subequal. | <i>C. australianus</i> (L. Koch). |
| - Distal spine of finger about twice the length of the proximal. | 3. |
| 3. The first tarsal segment of ambulatory legs only slightly longer than the other four together. | <i>C. pescotti</i> sp. nov. |
| - The first tarsal segment of ambulatory legs about $1\frac{1}{2}$ times as long as the other four together. | 4. |
| 4. Lateral eyes pigmented. | <i>C. seychellarum</i> Krpln. |
| - Lateral eyes without pigment. | <i>C. seychellarum diblemma</i> (Simon). |
| 5. Dorsal spines of hand subequal. | <i>C. neocaledonicus</i> Simon. |
| - Dorsal spines of hand unequal, the distal much the larger. | <i>C. milloti</i> Fage. |

The genus also includes the Galapagos species *C. insularis* Banks. The description is, however, insufficient to incorporate

that species in the above key and, further, the type-specimens, which should be in the collection of the Stanford University, California, seem to have been lost. Certainly Professor G. F. Ferris, to whom I am nevertheless indebted, can find no trace of them.

In the placement of *C. neocaledonicus* Simon, I have been guided by the figures given by Simon in support of his genus. Obviously these are not referable to the designated genotype *C. australianus* (L. Koch), which suggests that the genus was, in fact, described from a specimen of *neocaledonicus*. Other evidence tends to support this supposition. In erecting the genus, Simon (1892, p. 48) remarked that it "comprendant une seconde espèce de Nouvelle-Calédonie, encore inédite," and the definition of the genus, particularly where referring to the position of the lateral eyes, when compared with Kraepelin's descriptions of both species (1899, pp. 249-250), agrees better with *neocaledonicus* than with *australianus*. Unfortunately, I have not been able to obtain a specimen of Simon's species for examination; in view of the foregoing, it would be advisable for that species to be described in more detail.

Acknowledgments are also made to Dr. S. L. Hora, of the Zoological Survey of India, for details of the armature of the hand and finger of the two specimens of *C. seychellarum* Krpln. under his care.

Charinus pescotti sp. nov.

Figs. 1-3.

Female.

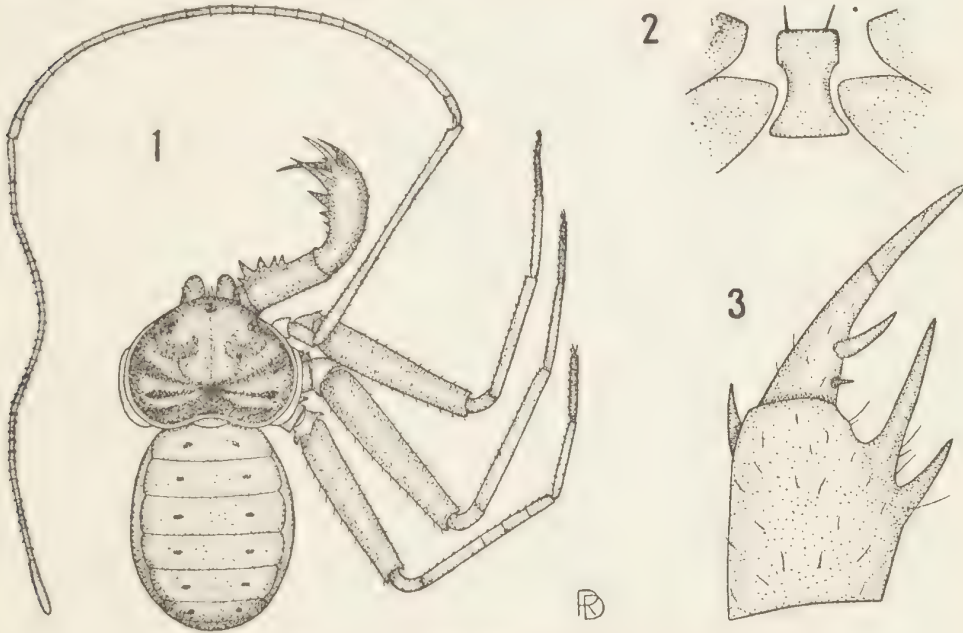
								mm.
Total Length	..	..	..	..	..	..	..	7.1
Length of Cephalothorax	..	..	..	..	..	..	..	2.8
Width of Cephalothorax	..	..	..	..	..	..	..	3.9
Length of Abdomen	..	..	..	..	..	..	..	4.3
Width of Abdomen	..	..	..	..	..	..	..	3.5
		Femur	Patella	Tibia	Meta-tarsus	Tarsus	Total	
Leg i	.. .. .	5.6	0.7	10.6	—	10.3	=	27.2
ii	.. .. .	3.6	0.7	2.7	1.8	1.2	=	10.0
iii	.. .. .	4.1	0.9	3.4	1.9	1.3	=	11.6
iv	.. .. .	3.7	0.8	3.4	1.7	1.5	=	11.1
		Femur	Tibia	Hand	Finger			
Palp	.. .. .	1.7	2.4	1.1	1.4		=	6.6

Carapace light reddish-brown with darker markings; chelicerae, palpi, and legs ii, iii, and iv, light brown; leg i somewhat darker; sternum and coxae yellowish. Abdomen yellowish-brown above and below, with darker markings.

Carapace obovate, convex, finely granular; grooves distinct, that behind the median eyes indistinct; anterior margin rounded, armed with six slender spines; posterior and lateral margins forming a narrow flange.

Eyes small and about equal in size; the two median, placed together on a low tubercle, are about their diameter apart and about the same from the anterior margin. Three lateral eyes to each side, close together on a low tubercle, about three times their individual diameter from the antero-lateral margin.

Chelicerae somewhat cylindrical in shape, projecting past the anterior margin of the carapace; promargin of falx-furrow armed with four teeth of which that nearest the base of the fang is deeply bifid, and the two intermediate are much the smallest; retromargin unarmed, fringed with long hairs. Fang moderately long, curved, armed on the inside of the curve with about four teeth decreasing in length distally.



Figs. 1-3. *Charinus pescotti* sp. nov.

Fig. 1. Dorsal view, omitting legs and palp on left side.

Fig. 2. Metasternum and portions of coxae iii and iv.

Fig. 3. Retrolateral view of left hand and finger.

Prosternum long and tapering anteriorly, provided with long and slender spines of which two are apical. *Mesosternum* short. *Metasternum* (Fig. 2) about twice as long as broad, excavated laterally opposite coxae iv, and, like the mesosternum, armed with a slender spine at each anterior corner.

Palpi relatively short, broad, and well armed. Femur armed dorsally with a row of four spines decreasing in length distally, and ventrally with three spines which likewise decrease in length distally; towards the base ventrally and near the proximal dorsal spine is a single trichobothrium. Tibia flat, about twice longer than broad, armed dorsally with five spines of which the penultimate is the longest, the one next behind it longer than the one next behind that, and the latter longer than the distal spine; armed ventrally with three spines which increase in length distally, the proximal minute, almost obsolete in paratypes. Hand (Fig. 3) flat, about one-fifth longer than broad, armed dorsally with two medial spines of which the distal is approximately twice the length of the proximal, and ventrally with one subapical spine. Finger jointed, the basal segment armed only dorsally with two spines of which the distal is more than twice the length of the proximal.

Legs armed with longitudinal rows of short slender spines ventrally and, on the femorae, dorsally. Leg i tactile; tibia composed of 23-27 segments; tarsus with 39-41 segments, of which the basal is much longer than the next segment, the distal segment being longer than the penultimate and modified into a tactile organ. Legs ii, iii, and iv ambulatory; each tarsus with two claws and pulvillus, composed of five segments in the approximate ratio of, in leg ii—44: 12: 3: 3: 19, leg iii—49: 14: 4: 4: 20, leg iv—52: 15: 5: 5: 21; a dorsal spur carrying an apical bristle springs from the apex of the penultimate tarsal segment and is equally as long as the distal segment; metatarsi somewhat thicker towards the apex and provided with numerous trichobothria; tibia ii and iii unsegmented; tibia iv composed of four segments in the ratio of approximately 65: 20: 24: 26.

Abdomen oval, finely granular, tergites i-vi with a pair of distinct impressions, telson wanting.

Locality. A single female (type) from Barron Falls, Queensland, collected by G. F. Hill, probably about 1923; and four females from Savo Island, Solomon Group, collected by R. R. Forster, about January 1944, under debris in coastal forest and coconut plantation.

Holotype in the National Museum of Victoria. Named in honour of the Director, Mr. R. T. M. Pescott, M.Agr.Sc., F.R.E.S., to whom I owe the privilege of examination of the arachnid collection. *Paratypes* in the Dominion Museum, Wellington, N.Z., and in the author's collection.

Obs. The Solomon specimens are somewhat duller in colour and, perhaps because of the varying size and age, show a tendency

towards a reduction in the number of spines on the femorae and tibiae of the palpi; however, I cannot find any difference important enough to warrant their separation from the Australian example. A much paler immature specimen with the paratypes measures about 2.7 mm. in length, and has the normal segmentation of leg iv, but the palpal spination of the older specimens is not fully developed; unfortunately both tactile legs are missing, being broken off at the patellar-tibial joint.

The only other Australian whip-scorpion known at present is *Charon annulipes* Lauterer, but is insufficiently described for determination of its true generic position. If the description is at all reliable, however, it is quite distinct from the present species, differing principally in having two large median eyes and *two* (?) small eyes on each side, in femur i being double the length of those of the ambulatory legs, in tibia i being divided into 26 and tarsus i into 47, or 49,¹ segments, in the proportionally shorter tactile leg, and in having dark brown rings on the ambulatory legs.

Genus STYGOPHRYNUS Kraepelin, 1895

A key to the species of this genus has already been given by Gravely (1915, p. 443), and it is apparent that the species fall into two distinct sections. The majority form a natural group around the genotype *S. cavernicola* (Thorell); to those mentioned by Gravely must be added *S. dammermani* Roewer (1928, p. 16), a species since described from Javanese caves.

S. moultoni Gravely is, however, quite distinct from its congeners. That this was recognized by Gravely is obvious from his remark (1915, p. 436) that for this species "a new genus ought perhaps to be established." Though in some respects the species described hereunder falls between *S. moultoni* and the more typical cavernicolous members of the genus, this second section seems sufficiently differentiated to warrant subgeneric rank at least, and consequently the subgenus *Neocharon* nov. is proposed for the reception of both species.

Subgenus NEOCHARON nov.

Differs from *Stygophrynus* Krpln. (*sensu stricto*) in being non-cavernicolous species, and having the distal supplementary spines of the hands, particularly the ventral ones, reduced in number below what is normal for the genus (at least three both dorsally and ventrally, *sec.* Kraepelin).

Type: *Stygophrynus* (*Neocharon*) *forsteri* sp. nov.

¹ In his description, Lauterer (1895, p. 414) states that the tarsus has 47 segments, but a few paragraphs previously refers to 49 segments.

Stygophrynus (Neocharon) forsteri sp. nov.

Figs. 4-6.

Female.

								mm.
Total Length	..	..	..	..	..	..	..	6.8
Length of Cephalothorax	..	..	..	..	..	..	..	3.0
Width of Cephalothorax	..	..	..	..	..	..	..	3.6
Length of Abdomen	..	..	..	..	..	..	..	4.2
Width of Abdomen	..	..	..	..	..	..	..	2.4

			Femur	Patella	Tibia	Meta- tarsus	Tarsus	Total
Leg i	..	..	6.9	0.5	12.5	—	14.3	= 34.2
ii	..	..	4.3	0.7	3.8	2.2	1.4	= 12.4
iii	..	..	4.7	0.8	4.6	2.2	1.5	= 13.8
iv	..	..	4.5	0.8	4.7	2.1	1.5	= 13.6

			Femur	Tibia	Hand	Finger	
Palp	..	..	1.9	2.4	1.0	1.2	= 6.5

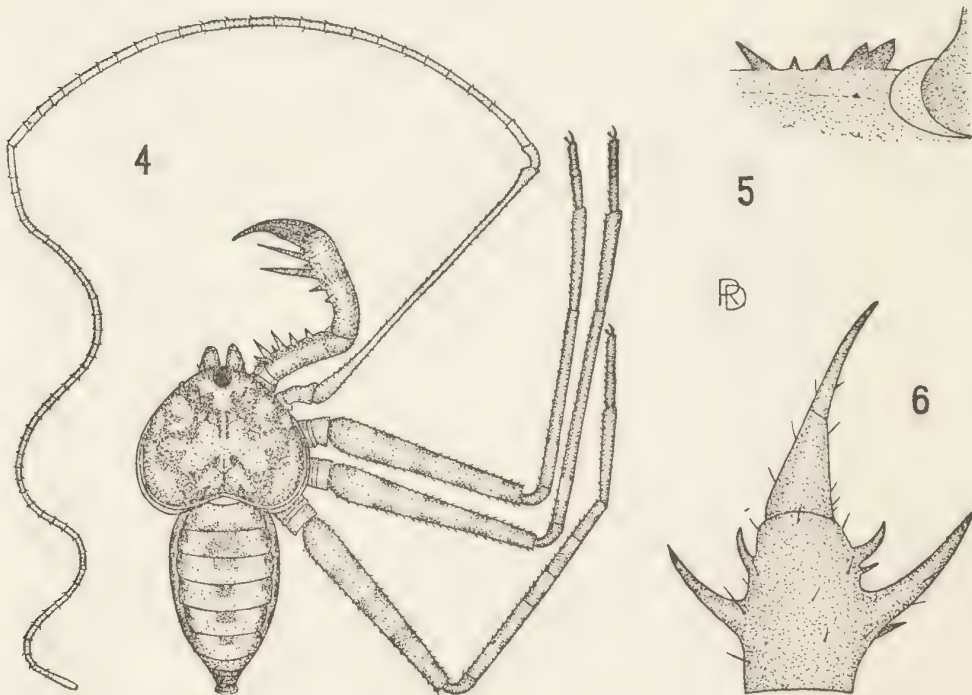
Figs. 4-6. *Stygophrynus (Neocharon) forsteri* subgen. et sp. nov.

Fig. 4. Dorsal view, omitting legs and palp on left side.

Fig. 5. Retrolateral view of right falx-margins.

Fig. 6. Retrolateral view of left hand and finger.

Carapace light brown with darker markings, median eye-tubercle black; chelicerae light brown; leg i light brown, distal

segment of tibia and proximal segment of tarsus yellowish, almost whitish, tactile organ yellowish; legs ii, iii, and iv light brown, femorae with four yellowish annulations, tibiae with subbasal yellowish annulation and a faint indication of a distal annulation; tibia iv also annulated on each segment distally; palpi light brown, femorae with somewhat darker medial and distal transverse bands, tibiae with medial transverse band; sternum and coxae yellowish. Abdomen light brown, each tergite with darker rectangular patches anteriorly in the median line and laterally, sternites yellowish.

Carapace obcordate, convex, finely granular; grooves moderately distinct; anterior margin straight truncate, armed with six slender spines; posterior and lateral margins forming a narrow flange.

Eyes small and about equal in size; the two median, placed obliquely on a moderately high tubercle almost touching the anterior carapacial margin and which is surmounted by a pair of small tubercles each carrying a slender spine, are slightly more than their diameter apart. The three lateral eyes on each side are grouped together on a low tubercle which is close to the antero-lateral carapacial margin.

Chelicerae somewhat cylindrical in shape, projecting past the anterior margin of the carapace; promargin of falx-furrow (Fig. 5) armed with four teeth of which that nearest the base of the fang is bifid, and the two intermediate slightly the smallest; retromargin with a minute tooth near the base of the fang. Fang moderately long, curved, armed on the inside of the curve with six small contiguous teeth of which the second from the base of the fang is the largest, the others decreasing in length distally.

Prosternum long, tapered anteriorly, provided with slender spines of which two are apical. *Mesosternum* subround, provided with two pairs of slender submedial spines. *Metasternum* also subround, about equal in size to the mesosternum, placed between coxae iii, provided with one pair of submedial spines.

Palpi relatively short, moderately broad, and well armed. Femur armed dorsally with a row of five large spines of which the proximal is about equal in size to the distal, the others decreasing in length distally; between the distal spine and the apical end of the segment is an additional minute spine, and between the second and the third an additional intermediate spine. Ventrally the femur is armed with four large spines of which the proximal is the smallest, the others decreasing in length distally;

between the distal spine and the apical end of the segment in the holotype is an additional minute spine. Tibia not very flat, about three times as long as broad, armed dorsally in the distal half with three large spines of which the distal is much smaller than the other subequal two, each of these three spines being separated in the holotype by a small spine, with another slightly larger than those latter placed between the distal large spine and the apical end of the segment; the proximal half of the tibia bears dorsally two spines of which the proximal is about equal in size to the supplementary spines of the distal half and is much smaller than its neighbour. Ventrally the tibia is armed with five spines, the distal much smaller than the penultimate, the others increasing in length distally; three minute spines are also present in the holotype, one placed between the apical end of the segment and the distal large spine, another between the latter and the penultimate, and the other between the penultimate and the medial. Hand (Fig. 6) not flattened, about one-half longer than broad, armed dorsally with a large submedial spine which has a small subsidiary spine inserted at its base, and a moderate distal spine proximally of which in the holotype is a minute spine. Ventrally the hand is armed with a large submedial spine and another much smaller distal spine. Finger jointed, without spines.

Legs armed with longitudinal rows of short slender spines ventrally and, on the femorae, dorsally. Leg i tactile; tibia composed of 25 segments; tarsus with 44 segments of which the basal is much longer than the next segment, the distal segment being much longer than the penultimate and modified into a tactile organ. Legs ii, iii, and iv, ambulatory; each tarsus with two claws and pulvillus, composed of five segments in the approximate ratio of, in leg ii—26:7:4:4:15, leg iii—27:7:4:4:18, leg iv—28:7:4:4:19; a dorsal spur carrying an apical bristle springs from the apex of the penultimate tarsal segment and is equally as long as the distal segment; metatarsi somewhat thicker towards the apex and provided with numerous trichobothria; tibia ii and iii unsegmented; tibia iv composed of four segments in the ratio of approximately 81:31:38:38.

Abdomen ovate, finely granular, telson wanting.

Locality. Three females from Savo Island, Solomon Group, collected by R. R. Forster, about January 1944, under debris in coastal forest and coconut plantation.

Holotype in the Dominion Museum, Wellington, N.Z. Named in honour of Mr. R. R. Forster, who kindly arranged for my

examination of these and other specimens from the Dominion Museum. *Paratypes* in the Dominion Museum, and in the author's collection.

Obs. This species comes closest to *S. moultoni* Gravely, which, however, differs principally by the hand being armed with two long spines dorsally and one only ventrally, and by the finger being armed dorsally with three minute spines.

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Brochopleurus australiae, sp. nov., holotype.

Ambulacrum and interambulacrum, near ambitus, to show detail of sculpture.
Magnification $\times 48$.

AN ECHINOID FROM THE TERTIARY (JANJUKIAN)
OF SOUTH AUSTRALIA

BROCHOPLEURUS AUSTRALIAE sp. nov.

By *H. Barraclough Fell*,
Victoria University College, Wellington, New Zealand.

Plate I.

(Received for publication October 13, 1948.)

Through the courtesy of the National Museum of Victoria, a collection of Australian Tertiary Echinoids was lent to me for comparison with similar material from New Zealand. The results of this will be published later, but, in the meantime, it is desirable to record an undescribed species included in the collection of the Museum which has been confused with *Paradoxechinus novus* Laube (1869). The species is referable to *Brochopleurus* Fourtau (1920), which genus differs from *Paradoxechinus* in a number of respects, the chief being that, in the former, the primary tubercles are each surrounded by a distinct radiating sculpture, whereas in the latter there is no such radiating sculpture, the primary tubercles being joined to their neighbours by straight lines of raised sculpturing, forming therefore a zig-zag line along each amb and interamb.

This appears to be the first record of the genus *Brochopleurus* from the Southern Hemisphere, Egypt and India being the two areas where it has hitherto been recognized—in both cases from strata regarded as Miocene. A very similar species occurs in the Waitakian stage (Middle Oligocene) of New Zealand, but further study will be required to determine if it is identical with the species from Australia.

As the genus *Brochopleurus* will be dealt with at greater length with other Tertiary Temnopleuridae in a later publication, no more need be given here than the brief diagnosis and a figure.

BROCHOPLEURUS Fourtau, 1920

Small forms of hemispherical shape. Pore-pairs in a nearly straight line. Primary tubercles non-crenulate, imperforate; a distinct radiating sculpture round the primary and partly also the secondary tubercles. Apical system (known in *B. sadeki* Fourtau) regularly dicyclie; gill-slits small, indistinct. Spines unknown. (Mortensen, 1943.)

Brochopleurus australiae sp. nov.

Fig. 1.

Height, 4.0 mm. Horizontal diameter, 9.0 mm. Peristome lost from holotype.

Apical system lost from the Australian specimens, but the New Zealand species, which is very similar, indicates the type of apical system normal for the genus, all the plates being exsert, to form the dicyclic arrangement.

Ambulacral plates, 10 (or 11?) in each series. Interambulacral plates, 9 (or 10?) in each series.

Interambulacral sculpture. — Each primary tubercle is surrounded by a radiating system of *ca.* 10 to 12 raised ridges, some of which anastomose with ridges from neighbouring primary tubercles. In general, 2 or 3 of the ridges link each tubercle with its immediate neighbour above as also below. The laterally placed ridges branch and end blindly. All the ridges are characterized by carrying several secondary tubercles, and the blind terminations of the ridges frequently carry secondary tubercles. Along the mid-zone of the interamb there is an irregular, sinuous ridge, broader and more flattened than the radiating ridges, and this too carries scattered secondary tubercles. Between the mesh-work formed by all these ridges, the intervening surface of the test is perfectly smooth.

Ambulacral sculpture. — Each pore-pair lies within a depressed oval area, with distinct horizontal ridges separating each depressed region from its neighbours above and below. The ambulacral mid-zone is traversed by more or less horizontal ridges, each carrying several secondary tubercles. Of these ridges, approximately every alternate one traverses the mid-zone from side to side, while the intervening ridges run only about half or two-thirds of the distance in each case. The primary tubercles form a vertical series on either side of the amb, between the mid-zone and the poriferous zone, and are situated on a well-marked sinuous vertical ridge. This ridge communicates on the outer side with the horizontal ridges separating the pore-pairs, and on the inner side with the horizontal ridges which cross the mid-zone. The test between the mesh-work of ridges is quite smooth.

Holotype. Specimen 4687 in the National Museum of Victoria.

Locality. Lower Murray cliffs, South Australia.

Horizon. This is stated to be Janjukian (i.e., Upper Oligocene or Lower Miocene).

REMARKS

Brochopleurus australiae may be distinguished immediately from other species of the genus by the transverse sculpturing of the ambulacral mid-zone, which is absent in the Egyptian and Indian species. On the other hand, it is very closely related to the forms from the New Zealand Oligocene already mentioned, which share this feature.

A second specimen, No. 4688 of the National Museum of Victoria, from the same locality, is evidently referable to this species. Its dimensions are: height 4.5 mm., horizontal diameter 9.5 mm., peristome diameter, 3.3 mm.

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THE PHYSIOGRAPHY AND PALAEOGEOGRAPHY OF THE RIVER YARRA, VICTORIA

*By Edmund D. Gill, B.A., B.D.,
Palaeontologist, National Museum of Victoria.*

Figs. 1-8.

(Received for publication August 4, 1947.)

INTRODUCTION

The normal drainage in Victoria is northwards from the Great Dividing Range to the River Murray, and southwards from the Range to the sea. The River Yarra flows from east to west, and it was early recognized that this paradox was due to a complicated history. Gregory (1903) maintained that the predecessor of the Yarra flowed southwards through the Gembrook Gap to the sea. Keble (1918) developed Gregory's idea. Edwards (1940) and the present writer (Gill, 1942) showed that the ancestor of the Yarra (the Wurunjerri River) flowed northwards on the east side of the Mt. Dandenong igneous complex, rounded this large monadnock at its northerly limit, then flowed southwards through Lilydale to the sea.

NOMENCLATURE

It is suggested that the following natural divisions of the course of the Yarra be adopted:

1. *Upper Yarra*—from source to the commencement of the Warburton Gorge (see Fig. 1).
2. *Middle Yarra*—Warburton Gorge to the commencement of the Warrandyte Gorge.
3. *Lower Yarra*—Warrandyte Gorge to the sea.

These are terms originated by Gregory, but they are now given precise definition.

UPPER YARRA

The River Yarra has its source in the Great Dividing Range on the remnants of a 4,000-ft. plateau. The surrounding prominences are Mt. Matlock 4,140 ft., Mt. Gregory 4,000 ft., Mt. Horsfall 4,000 ft., Mt. Observation 3,800 ft., and Mt. Donna Buang 4,080 ft. From its source to McMahon's Creek, the river flows approximately in a westerly direction. In this area the Yarra is carving out an intramontane basin. From the accompanying map (Fig. 1) it can be seen that the river flows through a valley bordered by more or less parallel mountain ridges (divides). The valley is almost mountain-locked, the river escaping through what I suggest be called the McMahon Gorge, between Reefton and McMahon's Creek. The flow of the river is at about right angles

to the strike of the basement rocks, which consist of a series of marine sediments—mudstones, sandstones, and shales. The physiography of the Upper Yarra is essentially youthful. There are many rapids, and terraces of torrent gravels are in evidence in a number of places.

The second part of the Upper Yarra from the McMahon Gorge to the Warburton Gorge owes its most characteristic features to control by the latter gorge. As Edwards (1932) has described, dacitic lavas, a granodiorite intrusion, hornfels, and a group of acid dykes stand athwart the course of the river, resulting in the formation of a gorge, and the partial reduction of the country upstream from it. Big Pats Creek is a tributary which enters just upstream from the gorge. It is a stream marginal to the granodiorite intrusion and its metamorphic aureole of hornfels.

MIDDLE YARRA

When the river emerges from the Warburton Gorge at Millgrove, it assumes a quite different character, and owes its form to different causes. It is for this reason that this section of the river is placed in a different category and called the Middle Yarra. The river flows through a mature valley with a wide flood plain. It receives at Yarra Junction the waters of the Little Yarra, at Launching Place those of the Don River, and at Healesville those of the Watts River. To the north the valley is walled by the igneous complex of Ben Cairn, and the Tool-be-wong granodiorite intrusion. To the south, granite and granodiorite outcrop (Baker, Gordon, and Rowe 1949). Obviously these rocks have played a major part in determining the direction of drainage in this area. In fact, the volcanic rocks of the Dandenong Ranges, and a series of granite and granodiorite intrusions to the east of it, are responsible for the westerly flow of the Yarra in its upper reaches (Fig. 2).

At Woori Yallock, the river changes course to a more or less northerly direction which is maintained for eight miles (measured in a direct line) to Healesville. The Woori Yallock Creek, which has a northerly course, flows more or less parallel with the Yarra from near Woori Yallock to its junction with the main stream north of Killara, three miles away. This is to be explained by the controlling effect of the nature and strike of the bedrock. Indeed, the country rock is the major factor in determining the course of the Middle Yarra between Woori Yallock and the Warrandyte Gorge. In early Tertiary times, when the present Yarra drainage system in this area was initiated, the extent of the Older Basalt lava field was the main factor. This, in turn, was determined by

- (a) the igneous suites surrounding much of the Woori Yallock basin, and
- (b) the prominence of bands of quartzitic rocks in the basement sedimentary series.

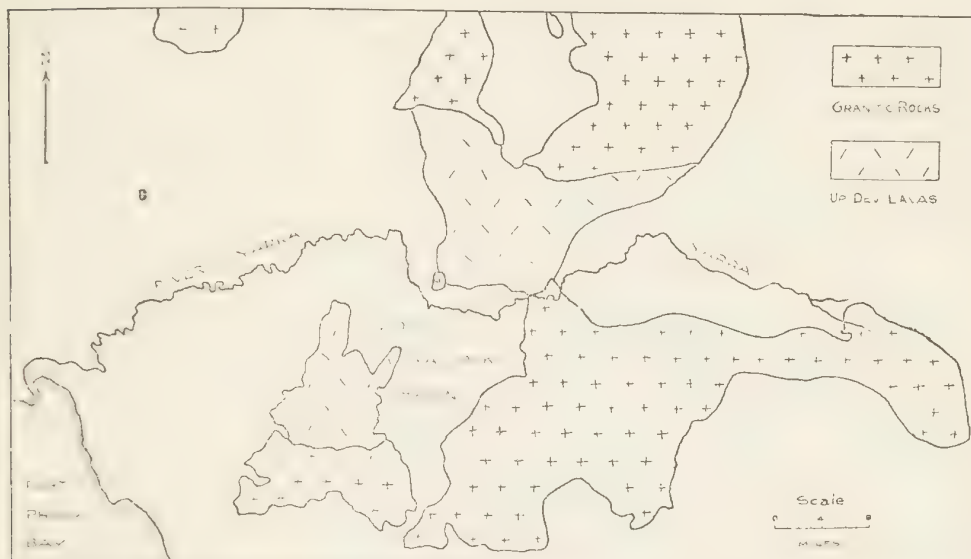


FIG. 2

Distribution of outcrops of granitic intrusive rocks and Upper Devonian lavas relative to the course of the River Yarra. These rocks account for the westerly flow of the river in its upper reaches.

The course of the Wurunjerri River, and the extent of the infilling lava flows has been discussed in a previous paper (Gill, 1942). As a direct result of the volcanic activity, the Wurunjerri River was blotted out, and the Yarra River developed in the north of this area as a stream marginal to the basalt. However, in the east it found a course to the east of the quartzitic Warramatte Hills instead of west of them as did the Wurunjerri River.

EASTERN AND WESTERN QUARTZITES

Reference to the map (Fig. 1) indicates how the course of the Middle Yarra from Killara to Healesville is closely related to the strike of the country rock. The hills forming the west bank of this part of the river are constituted of quartzites and quartzitic rocks of resistant character. The same beds outcrop on the other side of the synclinorium and form the west bank of the Yarra from Yarra Glen to the Warrandyte Gorge. These rocks are a conspicuous series in the district and give rise to notable physiographic features. I therefore suggest that they be known as the Eastern Quartzites and the Western Quartzites respectively.

North of Healesville the Eastern Quartzites have a general meridional strike, but it is of the order of N. 20° W. for six miles south of Healesville, and then at Killara it varies considerably. It is obvious that the direction of the river is closely affected by the strike of this series of hard beds.

The Western Quartzites have generally a meridional strike north of Yarra Glen, of about N. 25° E. for some eight miles to the Warrandyte Gorge, and then of about N. 10° E. along the Brushy Creek scarp. Once again the strike of the quartzites determines the directions of the streams. The Wurunjerri River impinged against the Western Quartzites (then the Wurunjerri Range) which deflected it southwards through Lilydale to the sea. The country between the Eastern and Western Quartzites has been considerably reduced by erosion, thus leaving them in relief by differential erosion. West of Yarra Glen the Western Quartzites form a large anticline, on each side of which are grey shales characterized by *Plectodonta bipartita*.

North of a line connecting Yarra Glen and Healesville, the Eastern and Western Quartzites are largely meridional in strike, but south of that line they splay out. This is due to the southerly pitch of the synclinalorium, which thus brings in the younger beds of the Lilydale area.

PHYSIOGRAPHIC PROBLEM OF THE QUARTZITES

Physiographers have discussed the problem of how the westerly flowing Yarra could breach the Western Quartzites and so flow on towards Melbourne. Keble (1918), Hills (1934) and others have discussed this problem. Actually the same problem applies to the Eastern Quartzites, for these are breached by the Yarra near Healesville. Hypotheses to explain these breachings are now offered.

BREACHING OF EASTERN QUARTZITES

The Middle Yarra follows the Eastern Quartzites for eight miles before breaching them near Healesville. That it should breach them at this particular place calls for explanation. The early Tertiary Wurunjerri River was confined between the Wurunjerri Range on the west (formed by the Western Quartzites) and a range on the east (formed by the Eastern Quartzites) which might well be called the Anti-Wurunjerri Range, on the analogy of Lebanon and Anti-Lebanon Mountains, Taurus and Anti-Taurus Mountains, and so on. This valley was filled with Older Basalt, and a stream developed around the northern margin of the flow. It appears that this stream cut back

across the Anti-Wurunjerri Range, and in so doing released the waters impounded behind it (see below). The first reason, then, for the position of this water-gap, is that the Older Basalt lava field extended to that point.

A second reason for the breaching of the Eastern Quartzites at Healesville is that there is an intrusion of quartz porphyry there. The river finds its way over the southern extension of this small boss. The intrusion has been fairly recently uncovered, as is shown by the fact that parts of it are still capped by country rock. The cutting on the west side of the railway tunnel (which pierces the porphyry) shows that there was some disturbance of the sediments by the intrusion. The broken bedrock would facilitate the breaching of the barrier at that point.

The Middle Yarra receives the waters of the Don River at Launching Place and the Watts River at Healesville. This greater volume of water is restricted in its passage through what may be called the Healesville Gorge, and so the river at this point is characterized by rapids. The widespread Healesville flats are evidence of ponding, and indeed at the present time they are flooded after heavy rains.

In Wurunjerri times, the ancestors of the Don and Watts Rivers must have carried their waters to the south of the Warramatte Hills and so connected with the Wurunjerri River. The infilling of the Wurunjerri Valley with basalt made this impossible, and the waters there must have ponded deeply to form a large lake until they were released by the breaching of the Anti-Wurunjerri Range. This ponding could be called the Healesville Lake. It is analogous to the Yarra Lake further west (represented now by the Yarra Flats), although the latter was probably never of the nature of a permanent deep lake like the former. The Healesville Lake probably stretched as far south as Woori Yallock, where residuals suggest this area to have been the margin of the Older Basalt lava field in this direction.

The alluvial flats from the Healesville and Yarra Lakes and the gorges which confine them are the most characteristic features of the Middle Yarra.

BREACHING OF WESTERN QUARTZITES

How the Wurunjerri Range (the Western Quartzites) could be breached to allow the Yarra through has engaged the attention of physiographers, and the following theories have been adduced:

1. *Keble* (1918, p. 148): "The Wurunjerri Range was breached by a tributary of Watson's Creek, and the basin of the Middle Yarra was diverted through the breach."

2. *Hills* (1934, p. 169) mentions the possibility of ejectamenta from a volcano at Lilydale blocking the pre-Older Basalt river and so causing flooding over the Wurunjerri Range to establish the present course of the Yarra. This theory was later abandoned.

3. *New Hypothesis*. The Nillumbik Peneplain stretched eastwards to the Dandenong Mountains, and did not cease at the Wurunjerri Range as formerly believed (Jutson, 1911). The break in the Wurunjerri Range owes its genesis to lateral differentiation in the Western Quartzites facilitating reduction, and to some structural disturbance. In other words, the Wurunjerri Range did not have to be breached because it already had a very low saddle in it. The infilling of the Wurunjerri valley with basalt flows some 300 ft. thick raised the thalweg of the new marginal stream so that it was higher than the saddle in the Wurunjerri Range, and flowed over it with ease. Even after erosion through most of Tertiary time and all of Quaternary time, the residual at Lilydale stands 674 feet above sea-level, which is roughly 275 feet above the bed of the Wurunjerri River as exposed in the Cave Hill quarry. If once southerly drainage had developed again after the extrusion of the basalts, no factors were operative in this area sufficient to divert the river.

THE YARRA PLATEAU

Gregory (1903) defined the Yarra Plateau which "once ran from the Strathbogie Ranges, across the present main divide between Mt. Disappointment and Mt. Arnold. It forms the old platform under the Dandenongs" (p. 84, fig. 49, p. 109). He defined it more narrowly when he said that the eastern border of the Plateau may be drawn through Queenstown, Christmas Hills, and Mooroolbark. "Most of the Yarra Plateau may be regarded as a shelf on the eastern border of the Melbourne basin" (p. 86).

Gregory thus presented two definitions of the Yarra Plateau which in reality refer to two different surfaces:

- (a) The first definition refers to a pre-Dandenongs (viz., Upper Devonian) surface as shown in his fig. 49, i.e., a Palaeozoic terrain.
- (b) The second definition refers to a shelf, the remains of which are at present clearly visible, i.e., a Cainozoic terrain. The second definition also limits the Plateau to a small area near Melbourne while the first refers to a large section of the State.

Gregory's first definition seems to have been largely disregarded by later writers. Jutson (1911), obviously taking the second



FIG. 3

The contours from the Military Map (Yan Yean and Ringwood Sheets) have been filled in between 600 and 650 feet to show the Yarra Plateau terrain on which the Kangaroo Ground Older Basalt stands (solid black); also between 400 and 450 feet to show the Nillumbik Peneplain on which the Lilydale Older Basalt stands (cross hatching). There are two monadnocks on this old peneplain—that formed by the resistant Western Quartzites, and that formed by the Older Basalt ("O.B." on map).

definition, suggested that country east of the Queenstown-Christmas Hills-Mooroolbark line be included (p. 474). Hills (1934, p. 163) has shown that Gregory was in error concerning the position of the ancient Divide. He also took Gregory's second definition, describing the Yarra Plateau as "the country from the Christmas Hills to the Plenty River, and from the Kinglake Escarpment to the divide on the Mitcham Axis."

In this paper Hills' definition is accepted, with a modification of the southern boundary of the Plateau. The map (Fig. 3) and sections (Fig. 4 a-c) show that the tops of the hills forming the old Yarra Plateau (as defined by Hills) as far south as Kangaroo Ground and Research are all about 600 feet to 650 feet above present sea-level. This is significant, because it is the level of the pre-Older Basalt terrain, as shown by the existing residuals. Diamond Creek as far as Hurstbridge plus Arthur's Creek on the west, and Watson's Creek on the east, are apparently streams that developed marginally to the Older Basalt flow. The upstream end of Diamond Creek, found north-east of Hurstbridge, is apparently a cross-cutting lateral. The ridges between these streams are apparently remnants of the old terrain which have been but recently stripped of their Older Basalt cover.

The relative positions of the 600 ft. summits suggests that those N.N.W. of the Kangaroo Ground basalt, and those forming a ridge between Arthur's Creek and the upper part of Diamond Creek, are the course of the pre-Older Basalt river. The ridge followed by the road from Pantom Hill to Queenstown (which reaches 700 ft. in places) would then be the eastern side of the valley, and the ridge from Yarrambat to Doreen (which reaches 725 ft. at Doreen) would be the western side of the valley.

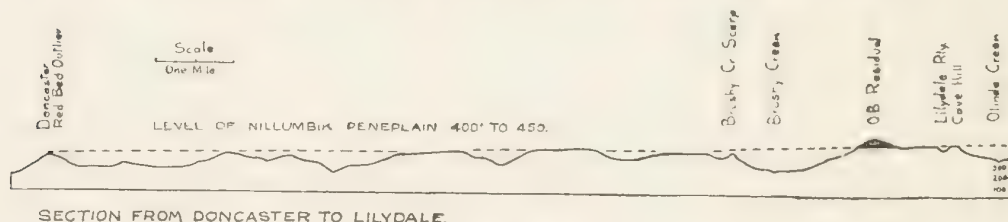


FIG. 4a

Section drawn from contours of Military Map, Ringwood Sheet, to show how the Nillumbik Peneplain stretched across as far as the Dandenong Ranges, and how the Older Basalt of the Wurrunjerri River flowed over it.

The general accordance of summit levels in this area gives indication of a definite terrain. As the Older Basalt and/or associated sands and gravels rest on these levels in a number of places, we know that this terrain is the pre-Older Basalt one, and so previous

A geological cross-section diagram showing the topography and subsurface geology of the Yarra Plateau and surrounding regions. The diagram is oriented with North at the top. The Yarra Plateau is a broad, relatively flat area in the center, bounded by a dashed line. To the west (left) is the Kangaroo Ground Q.B. Residual, shown as a shaded, rounded hill. To the east (right) is the Nillumbik Peneplain, shown as a lower, more irregular surface. The Yarra River is depicted as a winding line flowing from the east towards the west. Several creeks and tributaries are labeled: Diamond Creek to the far west, Kangaroo Ground Q.B. Residual, Watson's Creek and its tributaries to the west of the plateau, and Yarra River in Yarring Gorge and Yarra Falls to the east. A vertical scale on the left indicates elevations of 100 and 200 feet. The legend at the bottom identifies the symbols used: a solid line for the Yarra River, a dashed line for the Yarra Plateau boundary, a shaded area for the Kangaroo Ground Q.B. Residual, and a wavy line for the Nillumbik Peneplain.

Diagram illustrating the geological features and topography of the Yarra Plateau and surrounding areas, showing the Yarra River, Yarra Plateau, Kangaroo Ground Q.B. Residual, and various creeks and tributaries.

Legend:

- Yarra River
- Yarra Plateau
- Kangaroo Ground Q.B. Residual
- Nillumbik Peneplain

FIG. 4b

These facts also show that the Kinglake Escarpment is a very old feature. The cutting back of the escarpment was effectively retarded by the formation of the Older Basalt lava field. The rapid back-cutting of the scarp could not be re-initiated until the lava field had been removed. This has been done and the streams are now actively cutting back into the escarpment.

A geological cross-section diagram showing various geological features and elevations. The diagram includes labels for "NILEVAIR HILLS PLAIN", "YARRA RIVER", "HANGARUP CO. RESERVE", "DANBURY CREEK", "YARRA PLATEAU", "MOUNTAINS CO.", "MOUNTAINS CO.", "MOUNTAINS CO.", and "MOUNTAINS CO.". A vertical scale on the right indicates elevations from 0 to 100 feet.

Section drawn from contours of Military Map, Ringwood and Yan Yean Sheets, showing the relationship of the Nillumbik Penneplain and Yarra Plateau to one another and the Kinglake Escarpment.

When Jutson (1911) extended the Yarra Plateau from Gregory's Queenstown-Christmas Hills-Mooroolbark line to include the "Croydon Senkungsfeld" (i.e., the Croydon Lowlands and Yarra Flats) he gave the feature the new name of Nillumbik Peneplain (p. 477). Hills (1934, pp. 167-168, 173) adopted this term chiefly for the level of the stripped fossil plain, remnants

of which are seen along the Mitcham Axis. Modifications in the definition of the Yarra Plateau require modifications in the definition of the Nillumbik Peneplain. I suggest that this name be used for the peneplain standing from 400 ft. to 450 ft. above present sea-level. The map (Fig. 3) and sections (Fig. 4, a-c) show the extent of this peneplain. In addition to the Mitcham Axis there is a ridge running north-west to Doncaster, and another running south-west to Tally Ho and Mt. Waverley (cf. Hart, 1913).

Very important is the fact that the peneplain caused a gap in the Wurunjerri Range. Fig. 3 shows a stretch of about three miles of the Brushy Creek escarpment south of the Yarra River with summits at the Nillumbik Peneplain level. The east side of the Yering Gorge (Fig. 4b; also Gill, 1942, fig. 3) and the hills to the north of Lilydale are likewise Nillumbik levels. Most significant of all is the fact that the Older Basalt residuals at Lilydale and north-west of Lilydale stand on the Nillumbik terrain. This means

- (a) that the Nillumbik Peneplain stretched across to the Dandenong Mountains;
- (b) that this area was not down-faulted in post-Nillumbik times as claimed by Jutson (1911);
- (c) that the Lilydale Older Basalt is not a pre-Nillumbik peneplain lava flow, but one extruded after the formation of the peneplain.

Standing out from the Nillumbik Peneplain was a monadnock (or, if the plain were covered by sea, an island) which constituted the southern end of the Wurunjerri Range. This geographic feature owed its presence to the rocks of which it was composed—the Western Quartzites. As in the high country north of the Yarra, the elevated features are due to an anticline in the Western Quartzites.

On the other hand, the breach in the Western Quartzites where the Yarra passes through is due to

- (a) lateral differentiation of the country rock;
- (b) structural disturbance.

(a) Although there are no soft strata, the rocks in general are not so quartzitic as those, for example, on the Lilydale Highway where it descends the Brushy Creek escarpment.

(b) In the vicinity of Warrandyte, the Warrandyte Anticline divides into a number of small folds and then pitches out of existence. On the Wonga Park Road there are northerly dips for

over two miles, indicating pitch. It is in this area that the higher levels give way to Nillumbik Peneplain levels. Also where the Yarra River crosses the Western Quartzites, they take a major change in strike, swinging round to the north-east.

GENESIS OF THE NILLUMBIK PENEPLAIN

As re-defined, the Nillumbik terrain is a true peneplain. It is remarkable that there should be so little disparity of elevation in the Nillumbik Peneplain in view of the enormous differences in rock types. Some of the summits are sandstones, some shales, some highly indurated quartzitic horizons, and some are soft mudstones such as under the Older Basalt at Lilydale. In spite of these great differences in hardness, all the summits are between 400 and 450 feet, except for the monadnock of quartzites north and west of Croydon. Wicklow Hill, at Croydon, reaches 650 feet, the height of the Yarra Plateau.

An adequate explanation of the wide and even planation (in spite of variant rock types) of the Nillumbik Peneplain is called for, and also of the difference in level (about 200 feet) between it and the Yarra Plateau. Two possible explanations of the peneplanation suggest themselves:

1. *That the plain is one of marine denudation.* This theory is encouraged by the relationship of this area to the sea (although it must be remembered that there was no Port Phillip Bay then), by the fact that the slopes on its seaward sides have Miocene marine beds on them, and that the Red Beds on the peneplain itself appear to be fluvial sands and gravels spread along a shoreline. On this interpretation the gentle slopes on the seaward sides (south and west) of the peneplain would be a sloping sea-floor.

In criticism of this interpretation, it may be pointed out that Richthofen, followed by many eminent geologists, has denied that marine planation is possible, except on a subsiding land area. They have claimed that "waves can cut into a still-standing land mass only to a very moderate extent before they will exhaust themselves on the shallow beach which they have carved." More recently, Wentworth has concluded from studies in Hawaii that marine erosion cannot be a factor in peneplanation. However, in the case of the Nillumbik Peneplain, it could be argued that it was a gradually subsiding land (or rising sea) that caused the transgression by the sea which resulted in the deposition of the Miocene beds. Hall (1900, p. 40) envisaged such a process occurring.

2. *That the plain is one of subaerial denudation.* Alternatively, the Nillumbik Peneplain could have been formed by reduction to base-level by subaerial agencies. The slopes on the seaward sides and their Miocene strata are consistent with this interpretation too.

But the cause of the planation of the Nillumbik Peneplain needs to be considered along with the cause of the planation of the Yarra Plateau, and the difference in height between the two. If the Nillumbik Peneplain were cut by the sea and so covered by it, then the Yarra Plateau could have been formed by subaerial denudation. However, the difference in height of 200 feet does not favour this interpretation. Their relationships would be something like those of the present Port Campbell plain to the sea. Such difference in elevation would lead to dissection and not favour planation. Alternatively, the Nillumbik Peneplain and Yarra Plateau could have been one continuous peneplain which was disrupted by faulting. However, direct evidence of such faulting has not yet been found in the field.

Another possible explanation of the seaward slope to the south of the Nillumbik Peneplain is that it was originally part of the peneplain, but was involved in the warping (see Singleton, 1944) believed to have taken place to form the basin in which the Altona-Parwan lignites were deposited (Fig. 5).

AGE OF THE NILLUMBİK PENEPLAIN

The evidence for age is as follows:

1. The peneplain is older than the Older Basalt which filled the Wurunjerri River. The Older Basalts are believed to be from Oligocene to Lower Miocene in age. On palaeogeographical grounds (opp. page), it is believed that the Older Basalt at Balcombe Bay is part of the Wurunjerri flow or flows. The basalt at Balcombe Bay is overlain unconformably by Balcombian (Middle Miocene) marls. This means that the Nillumbik Peneplain is much older than Jutson thought (1911, pp. 477-478) when he first described it.

2. The peneplain is younger than the Lower Devonian marine sediments and the Upper Devonian igneous rocks of the Dandenong Ranges, both of which are affected by the planation. Fig. 3 shows how a ledge has been formed on the edge of the Dandenong lavas.

3. When the physiography of the State is considered, and the peneplanations which have been effected and then raised to higher levels, it is clear that the Nillumbik Peneplain must have been formed in Tertiary times.

At the close of the Eocene and in Oligocene times, it appears that the land gradually sank in relation to the sea, and in wide low-lying areas great quantities of lignite accumulated, especially in south central Victoria and southern Gippsland (see Fig. 5).

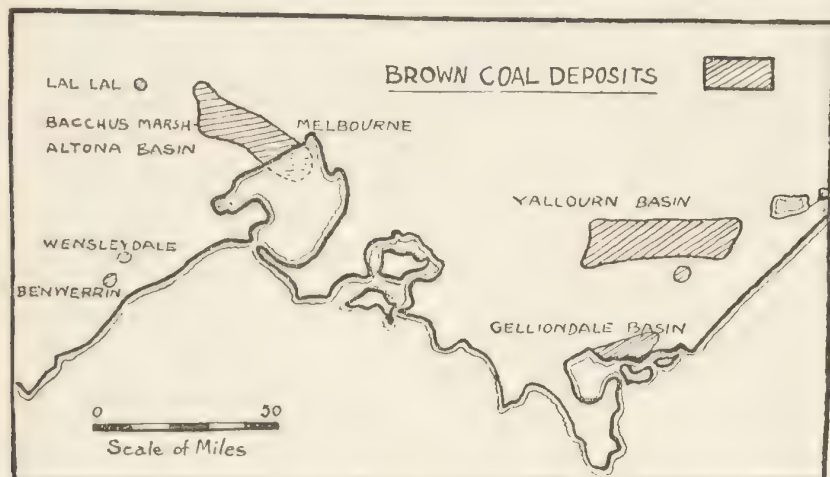


FIG. 5

Map showing extent of lignitic deposits in southern Victoria. The alignment of the Bacchus Marsh-Altona basin indicates the direction of early Tertiary drainage in that area.

The sinking was contemporaneous with considerable volcanic activity, and the two events may be not unconnected. The relative lowering of the land continued so that there was an extensive transgression of the former land surface, with deposition of Eocene, Oligocene, and Miocene marine beds on what is now the land. A number of the basalt flows were in part covered with these marine sediments. In this cycle of events the Nillumbik Peneplain was formed, and the Wurunjerri flow of basalt extruded upon its eastern extension.

In Lower Pliocene times the sea began to recede, and the rejuvenation of streams brought down copious torrent gravels and sands which were spread over the Nillumbik Peneplain to form the Red Beds, remains of which are seen as cappings on the hills to the north of the peneplain, and as a continuous cover further south. Still later, in an arid period, siliceous sand dunes were constructed over the Brighton-Sandringham area. They covered the Miocene marine deposits and Pliocene fluviatile-marine Red Beds. The recognition of the trend lines in the physiography of this area as dune lines (Whineup, 1944) explains a number of features Hart (1913) found it difficult to account for.

THE MITCHAM AXIS

Jutson (1911) gave this name to an east-west ridge running from north of Camberwell to Croydon. It is the divide between the Yarra river system and the streams to the south. Jutson claimed that this ridge is a warp axis, but admits that there is no evidence of this in the strike of the country rock. He depends on the difference in the slopes north and south of the axis, but this is due to the relative strengths of the streams on the two sides of the divide. If there were any recognizable late Tertiary warping, it would show in the deformation of the Nillumbik Peneplain.

The Mitcham Axis or Ridge is a feature of the present erosion cycle, and is due to back-cutting of streams from the rejuvenated Yarra (i.e., rejuvenated relative to the Nillumbik Peneplain) to the north, and streams entering Port Phillip to the south-west.

THE MOUNT WAVERLEY RIDGE

An equally large and important ridge or divide runs from Mitcham to Mount Waverley, with a branch running down through Glen Waverley to Wheeler's Hill (Fig. 6). The ridge is flat-topped, and averages about a mile wide. The flat top is part of the Nillumbik Peneplain, recently bared by the stripping away of the Red Beds. Remnants of the Red Beds are still to be seen in places as a thin veneer of gravel. The Mount Waverley ridge constitutes the western border of the large Dandenong Creek physiographic basin, which was carved out of the Nillumbik Peneplain.

If the main Mount Waverley ridge is projected, the line extends through Oakleigh to Highbett and Black Rock. This is a well-marked ridge of high country, as is seen by following the 100 ft. and 150 ft. contours on the military map (Ringwood Sheet). The map also shows how this ridge constitutes a divide. It was called the Cheltenham Axis by Hart (1913).

EARLY TERTIARY DIVIDES

Since Oligocene times, the Older and Newer Basalts have been the chief physiographic determinants in south-central Victoria. Before that time the granites and granodiorites (or rather, as Mr. R. A. Keble has pointed out to me, the metamorphosed rocks around them), along with the Upper Devonian volcanic suites, were the chief physiographic determinants. When these are plotted on a map they are seen, on the whole, to trace out the divides. The actual courses of the pre-Older Basalt rivers can be

largely recognized from the residuals of the lava flows that ran down them.

All divides, being elevated above the surrounding country, are subject to strong attack by subaerial erosion. Thus the divides of Oligocene times, having withstood erosion from then till now, will be much reduced and not so readily recognizable. Fig. 6 shows the reconstructed divides, and the river system, ancestral to the Yarra, which it is believed was in existence in early Tertiary times. The following are the divides which concern the present paper:

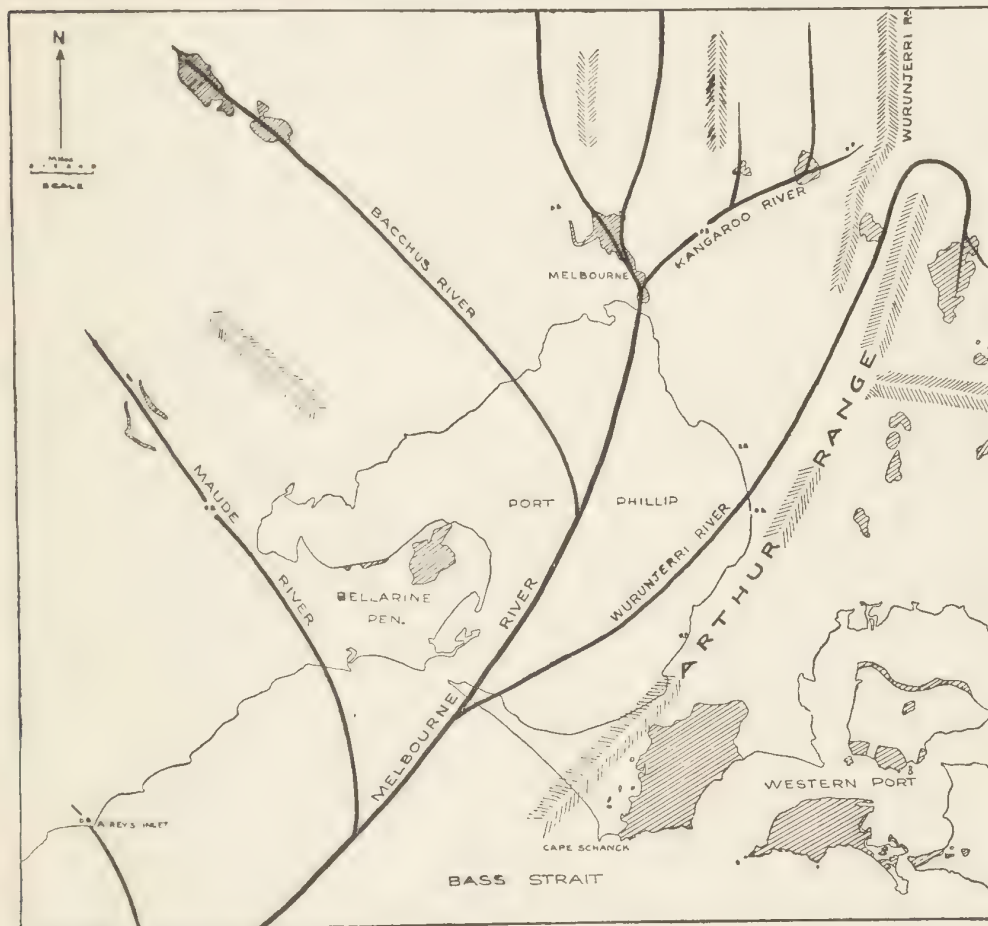


FIG. 6

Semi-diagrammatic map of the palaeogeography of the river system in early Tertiary (pre-Older Basalt) times which was ancestral to the Yarra River system. The areas cross-hatched represent Older Basalt outcrops.

(1) *Mt. Arthur-Dandenongs Divide*. This stretches from Mt. Arthur through Mt. Martha, Mt. Eliza, Lysterfield Hills (all of these are of granitic rocks) to the Dandenong Ranges (Upper

Devonian lavas and altered tuffs). In Oligocene times this must have been a prominent and important divide. It separated the Port Phillip area (then a land area) from the Western Port area (also a land area at that time). This divide is now very much reduced and is breached east of Carrum. Being a palaeogeographic feature of such size and significance, a special name for it is desirable. I propose that it be known as the Arthur Range, after Mt. Arthur.

The limit of this divide to the north is the termination of the Upper Devonian lavas at Coldstream, round which the Wurunjerri River flowed (Gill, 1942). How far the divide continued south-westerly towards King Island cannot be determined from our present knowledge, but it is probable, I think, that south-west of Cape Schanck the Western Port pre-Older Basalt river joined that of the ancestral Yarra (Melbourne River).

(2) *Dandenongs-Warburton Divide*. A line of granodiorite and granite intrusions stretches from the Dandenong Ranges to the Baw Baw Plateau (Fig. 2), and this determines the present westerly course of the Middle and Upper Yarra. In early Tertiary times the Woori Yallock Basin was in existence, and it was from there that the Wurunjerri River flowed (Edwards, 1940, Gill, 1942). The granitic intrusions to the east of the Dandenong Ranges therefore formed a divide in early Tertiary times, but probably only as far as the Warburton Ranges. The Upper Yarra is very young, comparatively, and one assumes that the Wurunjerri River drained only the Woori Yallock Basin.

(3) *Wurunjerri Range*. Later information shows that this did not merge into the Arthur Range as described by Keble (1918). The Wurunjerri River flowed between the two ranges.

(4) *Morang Divide*. The granite at South Morang was the core of a small divide between the early Tertiary Kangaroo River and the Melbourne River (see Fig. 6). It is marginal also to the Newer Basalt flow in that area.

(5) *Mt. Gellibrand Divide*. As the Morang Divide bordered the Melbourne River on the east so the Mt. Gellibrand Divide bordered it on the west. Once again a granite intrusion marks the line of the divide. There is some evidence to suggest that Older Basalt flows passed down each side of this prominence (see distribution in Fig. 6). Newer Basalt flows surround the Mt Gellibrand intrusion, which in early Tertiary times must have been a prominent landmark exercising an important physiographic control.

(6) *Anakies-You Yangs Divide*. This divide separated the river which flowed from the direction of Bacchus Marsh and the Maude River (see Fig. 6). The Anakies and You Yangs both consist of granitic rocks. They must have constituted a prominent range in early Tertiary times. They are still very prominent monadnocks. The ?Oligocene lignite in the Bacchus Marsh-Altona Basin (Fig. 5) indicates the alignment of the drainage at that time.

Further south-west the palaeogeography has not been studied sufficiently to indicate the pre-Older Basalt divide or divides. Since then the Otway Ranges have been uplifted, as is indicated by their very young physiography. This has naturally greatly complicated the reconstruction of the early Tertiary terrain.

However, the basalt at Airey's Inlet indicates the valley of some stream there. Probably the presence of tuff indicates that there was a vent at no very great distance.

EARLY TERTIARY RIVERS

(1) *Wurunjerri River*. This flowed from the Woori Yallock Basin round the northern end of the Dandenong Ranges igneous complex, southwards through where Lilydale now stands and, following the Arthur Range, through Frankston and Mornington, and so to the main north-south stream—the Melbourne River.

Older Basalt residuals and associated fluvial deposits are found in the Woori Yallock basin (Edwards, 1940) and in the Gruyere and Lilydale districts (Gill, 1942). Older Basalt is also preserved in the lower part of the course of this ancient stream by location below sea-level and by protection from overlying rocks. The basalt has been found in bores near Mordialloc and near Frankston in the Carrum Swamp area. It also occurs in Balcombe Bay where it is covered by the type Balcombian strata.

(2) *Kangaroo River*. The Yarra Plateau, as defined in this paper, was traversed by a river whose deposits are to be seen under the Older Basalt at Kangaroo Ground and in adjacent areas. When a river valley is filled with basalt, its thalweg naturally has the thickest covering of lava over it. For this reason the thalweg is usually the last part to be eroded. Marginal streams are set up which gradually work in to the centre, and cross laterals divide the flow into residuals. Applying this idea, we may infer that the curved string of hill-tops at Yarra Plateau level north of Kangaroo Ground indicates the course of the pre-Older Basalt river (Fig. 3). These are uncovered residuals (Keble, 1918) and, being the last to be uncovered, we may assume that they once

occupied the thalweg of the pre-Older Basalt valley. I suggest that this early Tertiary stream be known as the Kangaroo River. It drained the Kinglake escarpment and the Yarra Plateau.

Instead of continuing directly south, following the strike of the country rock, it appears that the Kangaroo River was deflected south-west to join the Melbourne River. The Geological Survey of Victoria geological map of the Parish of Sutton shows the lead under the Older Basalt at Kangaroo Ground turning to the south-west. On just what evidence that was based is not now known. However, the Warrandyte area directly to the south of Kangaroo Ground is one of highly indurated country rock, due to numerous intrusions, many of which have been mined for gold (Whitelaw, 1895). South-west is the general direction of drainage in the country between the meridians of Melbourne and Ringwood, and this was probably so in early Tertiary times owing to the strong influence of the Melbourne River (*q.v.*). The Melbourne River was a central stream of which all the others mentioned in this section were tributaries.

The Older Basalt at Ivanhoe is probably a marker of the main course of the Kangaroo River, while the residuals at Greensborough and north-east of Kangaroo Ground are indications of the position of branch streams. Both the Greensborough and Ivanhoe residuals are at a lower level than the Kangaroo Ground residual, and from this it is inferred that they were lower down the course of the river. However, if the Yarra Plateau owes its higher elevation to the Nillumbik Peneplain to faulting, then this has to be taken into account.

(3) *Melbourne River*. On the meridian of Melbourne there is a fossil valley of early Tertiary age. The Moonee Ponds Creek has now cut through the covering rocks in a number of places to this ancient valley, which has been preserved first by a sheet of Older Basalt, and then by a sheet of Newer Basalt. For instance, a section in the Moonee Ponds Creek at North Essendon reveals:

Newer Basalt (youngest).
Quartzite, sands, and gravels.
Older Basalt.
Sands and silts.
Silurian bedrock.

The bedrock at this point is about 67 feet above sea-level, and, like the Silurian inlier on which part of Melbourne is built, constitutes a section of the east bank of what I propose to call the Melbourne River. Skeats' (1909) figure 2 shows part of this river bed, mostly below sea-level. Older Basalt still remains in the lower

parts of the valley. It occurs between 70 feet and 80 feet below datum (i.e., L.W.M. for Hobson's Bay) at Spencer Street bridge, Melbourne.

Keble (1946) has suggested that the Melbourne River flowed over the Bellarine Peninsula and so down towards Cape Otway. Further information now obtained indicates that it probably flowed to the east of the Bellarine Peninsula because—

(a) Judging by the Older Basalt residuals further north, the thalweg of the Melbourne River was hundreds of feet below sea-level at Port Phillip Heads, whereas the Older Basalt on the Bellarine Peninsula (Daintree, 1861; Diamond Drills in Victoria, 1885) is far too high to fit in with this physiographic pattern.

In connection with bridge-building projects, traverses of bores have been made across the River Yarra at Melbourne as follows:

Location of bores		Authority	Depth of bedrock in feet below datum.
i	Punt Road	Country Roads Board	57·57
ii	Swan Street	Ditto	62·6
iii	Russell Street	Ditto	70·33
iv	Spencer Street	Victorian Railways	82·8

The locations are shown in Fig. 7. The present Yarra, the pre-Newer Basalt Yarra, and the Kangaroo River (i.e., from early Tertiary times till now) have all passed over the same course in the area where the bores were sunk. This was due to constriction between the hard Silurian outcrops represented at present by Government House Hill and Russell Street Hill (Fig. 7).

- i. The Punt Road section shows mostly silt above the bedrock, but a little sand is intercalated.
- ii. The Swan Street section is also mostly silt, but on the south bank of the river the bores penetrated basalt.
- iii. The Russell Street section reveals basalt on the north bank of the river. A seam of "drift sand" at about the level of the top of the basalt separates upper and lower silts over the thalweg of the river bed in the bedrock.
- iv. The Spencer Street sections have been published by Chapman (1929). They show in order from below up bedrock, Older Basalt, clay, Newer Basalt, lignite, shell marl, drift sand, and mud. The position of the Older Basalt indicates that the bedrock is the level of the pre-Older Basalt River (Kangaroo River) at this point, and so probably also in the other sections quoted.

The figures in the above table show an average declivity in the thalweg over the two miles between Punt Road and Spencer Street of 12.6 feet per mile. If this average declivity is assumed for the 36 miles from Spencer Street to the Port Phillip Heads, then the pre-Older Basalt river there must have been 454 feet lower, i.e., 536 feet below datum. The declivity of a stream is commonly reduced in its lower reaches, especially as the coast is reached.

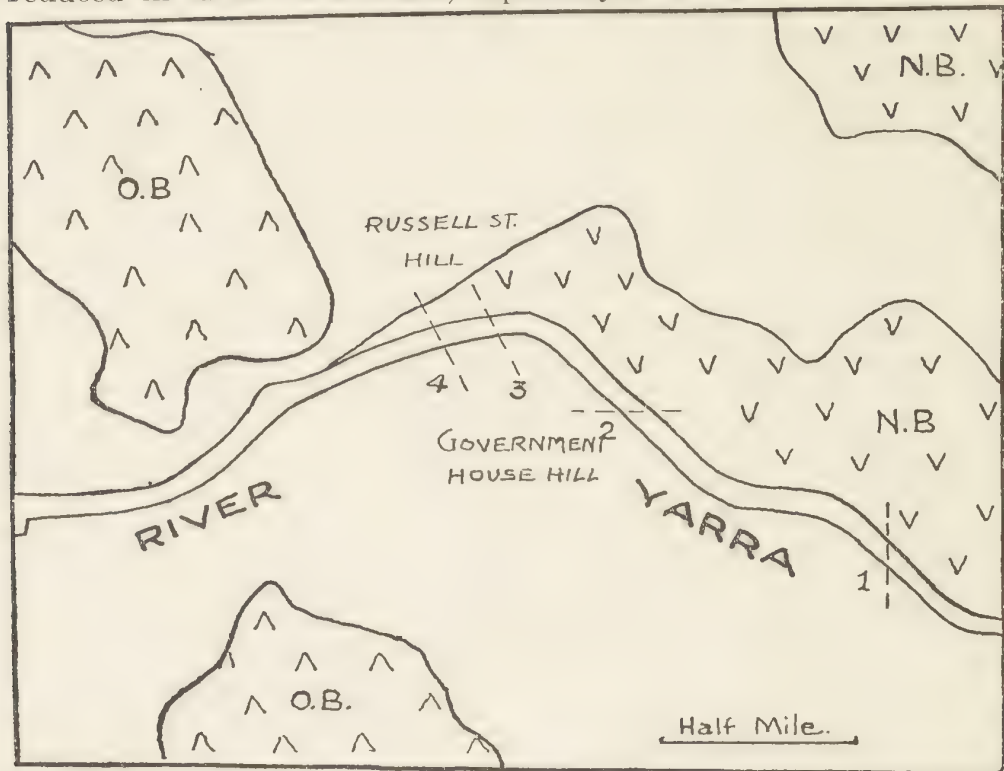


FIG. 7

Map to indicate positions of bore traverses across the River Yarra at Melbourne. 1 is Punt Road, 2 is Swan Street, 3 is Russell Street, and 4 is Spencer Street. O.B. = Older Basalt. N.B. = Newer Basalt.

However, the coast then was probably in the vicinity of Cape Otway (as in the Pleistocene), and 12.6 feet per mile is already a low declivity, i.e., 1 in 420. So the figure arrived at is probably of the right order.

In a previous paper (Gill, 1942), the declivity of the Wurundjerri River was calculated to be 15 feet per mile. Applying this figure to the 56 miles from Lilydale to Port Phillip Heads gives 840 feet, from which must be subtracted 378 feet which is the elevation of the thalweg at Lilydale above sea-level, viz., 462 feet below datum.

Comparing the figures from the Wurunjerri River (462 feet) and the Kangaroo River (536 feet), we may assume that at the site of the present Port Phillip Heads, the pre-Older Basalt river system was of the order of 500 feet below datum. As further information is obtained about the thalwegs of the above rivers and the other rivers of the system, it should be possible to determine fairly accurately the depth below present sea-level of the Melbourne River at that point. When this is done, it will be possible to determine how much depression is there due to eustatic low sea-levels and how much due to faulting along Selwyn's Fault and others, if any. As the declivities are measured in tectonically stable areas, the difference between the calculated level of the bedrock and its actual depth will be a measure of the faulting that has occurred. The Sorrento Bore (Chapman, 1928) penetrated 1,680 feet of sediments and aeolian materials without reaching bedrock. On present knowledge, it may be said that 500 feet of this depth is due to eustatic emergence resulting in down-cutting of the river bed to that depth below present sea-level, while 1,180+ feet is due to faulting.

A further check on the depth to which the pre-Older Basalt river system eroded below present sea-level may be obtained by a study of the palaeogeography of the Western Port Older Basalts. These are also found far below sea-level, although once again there has been faulting. However, the declivities can be worked out from the stable areas. The Western Port system apparently drained into the Melbourne River south-west of Cape Schanck, and so the depth of the thalweg of its main stream should fit in with those of the Port Phillip system.

The depth of the pre-Older Basalt river system below present sea-level has not always been taken into account in the geological interpretation of some areas. For example, Older Basalt is found below sea-level between Mornington and Frankston, and this has been attributed to down-faulting. That some faulting has taken place is indicated by the dip of Tertiary rocks at Frankston. However, the depth of the Older Basalt is no doubt due chiefly to the position of the pre-Older Basalt river bed.

From the foregoing paragraphs it is clear that the Melbourne River could not have passed over the Bellarine Peninsula, unless that has been up-faulted to the order of 500 feet. There is no reason to hypotheate this.

(b) A second reason for considering that the Melbourne River flowed east of the position of the Bellarine Peninsula is that such a course follows the middle of the early Tertiary river valley. I

consider the Older Basalt on the Bellarine Peninsula and at Balcombe Bay to be residuals on the flanks of the ancient valley. They indicate that the Older Basalt had a thickness of the order of 1,000 feet, because the Older Basalt on the Peninsula reaches 470 feet, and the bottom of the valley was something like 500 feet below present sea-level. Older Basalt over 1,000 feet thick occurs in Western Port.

(4) The disposition of the Older Basalt residuals north-west of Melbourne suggests (as one would expect) that a tributary of the Melbourne River drained the country on the west side of the Mt. Gellibrand granitic intrusion.

(5) Another stream flowed from the direction of Bacchus Marsh, called the Bacchus River in Fig. 6. Borings at Altona did not show any Older Basalt, but probably it was worn away from that area as from most of the lower part of the river system. Pleistocene low sea-levels resulting from glacio-eustatic emergence rejuvenated the post-Older Basalt streams so that most of the Older Basalt was stripped away. The low patch between Mornington and Frankston remains because the Wurunjerri River was diverted to form part of the Yarra system. No stream of any importance was therefore rejuvenated over this part of the Older Basalt lava field.

(6) Yet another stream flowed from the direction of Maude, as shown by the Older Basalt residuals there. This is called the Maude River in Fig. 6. It is the ancestor of the Barwon River. The relationship of the basalt residuals to the Tertiary rocks shows (according to Singleton, 1941) that the lava flows at Maude and Curlewis (on the Bellarine Peninsula) were not contemporaneous. Either the two deposits belong to different valleys, or/and the lava to different eruptions. The palaeogeography of this area has not been worked out, and the course of the Maude River shown in Fig. 6 must be regarded as tentative.

(7) Basalt and tuff at Airey's Inlet indicate the presence there in early Tertiary times of a valley, as lava, like water, always seeks the lowest levels. Ash volcanoes are generally found near the coast, as they very often originate from hydro-explosions. It is interesting to note this general rule holding for the ?Oligocene vulcanism, for apparently all the inland volcanoes were effusive ones, while those producing tuff are to seaward.

Noetling (1910), Dannevig (1915), and Keble (1946) have discussed the drainage of the Bass Strait area in Tertiary and Quaternary times.

POST-OLDER BASALT RIVER SYSTEM

The extrusion of the Older Basalt lava flows apparently brought about the following changes:

(1) In the Woori Yallock Basin the Wurunjerri River was succeeded chiefly by a stream which flowed along the northern boundary of the lava field. This stream was diverted over a saddle in the Wurunjerri Range, and linked with a stream flowing along the southern margin of the Kangaroo Ground lava field. As no Newer Basalt lavas were extruded in these areas, this stream is the same as the present Yarra River. It is thus seen that the Yarra consists of parts of three early Tertiary rivers (or more accurately, their post-Older Basalt successors), viz., the Wurunjerri, the Kangaroo, and the Melbourne.

(2) The pre-Newer Basalt Plenty River has been traced by Jutson (1910), i.e., the stream which was established after the extrusion of the Older Basalt. It was probably on the eastern margin of the Melbourne River lava field. New streams usually start along the margins of lava flows, and so the position of the post-Older Basalt streams may, on the whole, indicate the extent of the Older Basalt lava field.

(3) The Melbourne River lava field was a broad one, and a new stream developed down the middle of it—the pre-Newer Basalt Yarra. Possibly the great thickness of basalt in this field caused a slight slumping which would cause the water to take this course.

The River Yarra flowed along the north of the Woori Yallock Basin lava field, over the saddle in the Wurunjerri Range, along the southern margins of the lava fields represented by the Kangaroo Ground and Ivanhoe residuals, through the present suburbs of Fairfield, Collingwood and Burnley, and so to the city area, where it flowed along the edge of the Older Basalt past the Botanical Gardens and across the Albert Park lakes (i.e., skirting the Older Basalt on which South Melbourne is built), and so down the middle of the Melbourne River lava field to the sea. This course, in its lower reaches, was deeply entrenched by low eustatic sea-levels in the Pleistocene.

(4) The Dandenong Creek no doubt developed as a stream marginal to the Older Basalt in the valley of the Wurunjerri River. Pleistocene low sea-levels would make this stream a very active one, and its work was not interfered with by Newer Basalt flows as in other parts of the drainage system of Port Phillip. Dandenong Creek has carved out a more or less circular physiographic basin north of Dandenong, because it is constricted at the

latter locality between the southerly extension of the Western Quartzites and a granitic intrusion (part of the old Arthur Range). The basin is one of differential erosion, and it is to be noted that a branch of the Dandenong Creek south-east of Ringwood has succeeded in breaching the Western Quartzites at a weak place and in corroding a young valley west of the main quartzitic horizon.

The headwaters of the Dandenong Creek are very little different in level from Brushy Creek, which flows into the Yarra. In a short time, from a geological point of view, the Dandenong Creek will capture Brushy Creek and reverse its direction of flow, so that the Yarra will flow down the Dandenong Creek. Thus the early Tertiary drainage system of the Wurunjerri River will be re-established. However, the constriction at Dandenong will no doubt cause flooding, and the river will cut a gorge there.



FIG. 8

Map to indicate extent of Miocene marine transgression. Nearly all deposits are found below the level of the Nillumbik Peneplain.

TERTIARY MARINE TRANSGRESSION

After the Older Basalt had been eroded (a time interval of unknown duration), a marine transgression of the land on a large scale took place. Figure 8 shows the approximate extent of this transgression in Victoria. The whole of the seaward half of the Port Phillip river system was drowned, the Yarra was bestrunked, and former branches (like the Barwon) became independent streams.

The physiographic effect of the transgression was the opposite of rejuvenation (physiographic senescence, if a term may be coined), with the result that the products of erosion were relatively small. Widely distributed deposits of limestone, originating chiefly from the calcareous tests of marine organisms, were laid down. All in the area concerned in this study are Miocene in age.

The Miocene deposits contrast strongly with the succeeding Pliocene Red Beds, which consist of sands and gravels resulting from the rejuvenation of streams following recession of the sea. At Beaumaris, on Port Phillip Bay south-east of Melbourne, remains of a Cheltenhamian (Upper Miocene) beach have been found above the Middle Miocene limestone. This suggests that regression of the sea was in progress in Upper Miocene times.

THE RED BEDS

Regression of the sea meant rejuvenation. Sands and torrent gravels were swept down the valleys and spread out on the former sea-floor left bare by the retreating sea. They thus formed a coastal plain covering the Nillumbik Peneplain and seaward slopes.

The regression of the sea also meant the engrafting of the river system, so that a condition like that figured by Gregory (1903, fig. 50) obtained. This was, of course, before the formation of Port Phillip.

GLACIO-EUSTATIC CHANGES

During the Pleistocene Period, the eustatic low sea-levels caused intense rejuvenation which resulted in the reduction of the Older Basalt lava field. The sections across the Yarra River described earlier in this paper show that the Older Basalt was practically stripped from the bed of the Kangaroo River at Melbourne. Hall (1909, p. 30) records that at Port Melbourne a bore pierced 170 feet of deposits before reaching the bedrock. As already indicated, the low sea-levels resulted in corrosion to a depth of the order of 500 feet on the site of the present Port Phillip Heads.

Another process at work during low sea-levels was the building of calcareous sand dunes now consolidated, and a notable feature of the coast (Hills 1939, Coulson 1940, Gill 1943, Keble 1946). These dunes partly filled the estuary cut by the rejuvenated river system, but the dunes themselves were planated when the sea advanced again. Later new dunes were built on the planated bases of the old ones.

The fact that the Newer Basalt was also stripped away from the bed of the Yarra at Melbourne during eustatic low sea-level or

levels indicates that the flow or flows there are of Pleistocene age. The lignite, shelly marl, and such beds are evidence of alternation of conditions. The high eustatic levels would bring about the deposition of estuarine beds. The Sorrento Bore also provides ample evidence of alternation of conditions (Chapman 1928, Keble 1946).

GENESIS OF PORT PHILLIP BAY

The bay owes its origin chiefly to Selwyn's Fault, which developed probably in Holocene times and is still active. The fault runs along the eastern margin of much of the bay (Keble, 1946, fig. 2), and has brought about a block-tilting effect which allowed encroachment by the sea. The crowding of the submarine contours on the eastern side of the bay (see Keble's figure 2) is probably due to the faulting plus the scouring developed thereby. However, if the bay originated by faulting alone, the deepest water would be along the fault line, but this is not so. The deepest water is in the middle of the bay. This is due to the fact that a deep and wide valley was carved out during eustatic low sea-levels, so that when the sea came to its present level a large estuary had already been formed. The fault has increased the area of encroachment. Keble (1946) has given the name Bellarine Fault to the hinge of the tilt-block.

In late Pleistocene times, dune building established a bar across the present Port Phillip Heads. The mouth of the Yarra migrated to different places between Mount Arthur and the Bellarine Peninsula, for as one exit was blocked by dune-building, another had to be found. Keble (1946) has described the Bay Bar and the various debouchements which can be traced in the submarine contours. The infilling of the Pleistocene valley of the Yarra is still proceeding in the bay, although negatived to a certain extent by movement along Selwyn's Fault.

The formation of Port Phillip Bay by flooding of the Pleistocene valley and movement on Selwyn's Fault betruncked the Yarra river system, so that streams which once flowed into the Yarra now debouch into the bay.

NEWER BASALT CYCLE

The present cycle of erosion was precipitated by the extrusion of the Newer Basalts. The Upper Yarra and Middle Yarra were not affected, and thus their courses are much older. The Lower Yarra was forced against its southern valley wall, and its thalweg raised considerably. The gravels and other fluvial deposits

found beneath the Newer Basalt at Burnley and Collingwood show that the pre-Newer Basalt river bed was well below sea-level at those points. This suggests that the basalt was extruded in a glacial low sea-level period.

Ponding of the Yarra River occurred at Fairfield, where the river was obstructed by the lava flows. Similar ponding occurred in some tributary streams with resultant deposition of alluvium. The shell-beds of the Williamstown area, a product of a post-glacial eustatic sea-level, repose on the Newer Basalt. (Hills, 1940a.)

MAIN CONCLUSIONS

1. The Upper Yarra owes its westerly flow to a line of granitic intrusions, i.e., to differential erosion.
2. The Middle Yarra breached the Eastern Quartzites at Healesville because that was the edge of the Woori Yallock Basin lava field, and the site of a disrupting quartz porphyry intrusion.
3. The Lower Yarra breached the Western Quartzites through post-Older Basalt drainage being diverted over a saddle in the Wurunjerri Range. This was possible because the lava was some 300 feet thick and lifted the thalweg of the stream above the level of the saddle.
4. Two pre-Older Basalt peneplain surfaces are described—the Yarra Plateau (600-650 feet) and the Nillumbik Peneplain (400-450 feet).
5. The pre-Older Basalt river system and divides are described in outline.
6. The thalweg of the main stream (Melbourne River) was of the order of 500 feet below present sea-level on the site of the present Port Phillip Heads. The remainder of the depression shown by the Sorrento Bore is due to Selwyn's Fault.
7. After extrusion of the Older Basalt, marine transgression over a large part of the State betrunken the ancestral Yarra River system, and brought about physiographic senescence. The seaward basalts were covered with Tertiary strata, which were mostly limestones, because the depressed river system brought comparatively little material for deposition.
8. Retreat of the sea brought rejuvenation and the deposition of the Red Beds sands and gravels which resulted therefrom.

9. Pleistocene eustatic low sea-levels caused streams to deeply erode the Older Basalt. The Newer Basalt at Melbourne lies in a valley below sea-level, and is itself affected by corrosion extending far below sea-level. It is therefore Pleistocene in age. During low sea-levels also, extensive calcareous dunes were built. High sea-levels have resulted in deposition within the low sea-level valleys, and in the planation of dunes.
10. The Lower Yarra valley which was carved out by Pleistocene eustatic low sea-levels was flooded to form an estuary. The sea encroached still further to form Port Phillip Bay when (probably in late Holocene times) the development of Selwyn's Fault caused block-tilting.
11. The extrusion of the Newer Basalts caused ponding at Fairfield, and the forcing of the Lower Yarra against the southern wall of its valley as a marginal stream.
12. This study is far from complete. It is but a step along the long road of research to a complete account of the physiography and palaeogeography of the River Yarra.

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SUR QUELQUES PAUROPODES D'AUSTRALIE (Récoltes de M. le Professeur O. W. Tiegs)

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Fig. 1.

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D'Australie, nous ne connaissons actuellement que 6 espèces de Pauropodes: 5 ont été décrites par HARRISON (1914) qui les a découvertes aux environs de Sydney (Broken Bay) et les a appelées *Pauropus amicus*, *P. australis*, *P. novae-hollandiae*, *P. Burrowesi* et *Eurypauropus speciosus*; la 6e espèce a été trouvée à Belgrave (Victoria) par TIEGS (1943) qui l'a décrite sous le nom de *Pauropus silvaticus* et en a étudié longuement le développement et l'anatomie (TIEGS 1947).

CHAMBERLIN (1920) a mentionné, sans plus, les captures de HARRISON, et a placé par erreur l'*Eurypauropus* dans la famille des *Pauropidae*!

BAGNALL (1935) a défini le genre *Australopauropus* pour y placer cet *Eurypauropus*, mais j'ai pensé que ce nouveau genre est probablement synonyme du genre *Samarangopus* créé par VERHOEFF (1934) pour *Eurypauropus Jacobsoni* Silvestri le Java, et c'est dans ce genre établi par VERHOEFF que j'ai placé l'*Eurypauropus* australien (REMY 1937).

VERHOEFF (1934) pense que les 4 formes classées par HARRISON parmi les *Pauropus* seront vraisemblablement placées dans d'autres genres quand elles auront été mieux étudiées, mais il n'indique pas les raisons qui l'ont amené à émettre cette opinion.

Pauropus australis est certainement un *Pauropus*; sa plaque anale est construite sur le plan de celle des autres représentants authentiques du genre: *P. Huxleyi* Lubbock (génotype) et sa var. *lanceolatus* Remy, *P. intermedius* Hansen, *P. robustus* Hansen, *P. spectabilis* Hansen, *P. furcifer* Silvestri, *P. silvaticus* Tiegs, et mes *P. Dawydoffi*, *P. bostonensis*, *P. Bagnalli*, *P. B.* var. *Leruthi*, *P. numidus*; la forme du rameau antennaire sternal, la chétotaxie du pygidium sont également d'un *Pauropus* vrai.

Par contre, comme je l'ai déjà dit ailleurs (REMY 1935), *Pauropus Burrowesi* doit être placé dans le genre *Allopauropus*: à son rameau antennaire sternal, en effet, l'angle antéro-distal est

tronqué obliquement, ce qui fait que le bord antérieur de ce rameau est plus court que le postérieur, caractère qui a été précisément retenu par SILVESTRI (1902) pour séparer son nouveau genre *Allopauropus* du genre *Pauropus*, chez les représentants duquel le bord antérieur et le bord postérieur du rameau antennaire sternal sont subégaux; de plus, la plaque anale de l'espèce australienne est tout à fait différente de celle d'un vrai *Pauropus*; ses caractères, ainsi d'ailleurs que ceux de la chétotaxie du pygidium, obligent, au contraire, à placer l'animal au voisinage immédiat d'un *Allopauropus* authentique: *A. Mortensenii* Hansen, ce qui, d'ailleurs, a déjà été fait par HARRISON.

Il est difficile de mettre *Pauropus amicus* dans le genre *Pauropus* pour les raisons suivantes (caractères observés chez des individus à 9 pp.¹): 1° l'angle antéro-distal du rameau antennaire sternal est tronqué (particularité présentée par les *Allopauropus*, ainsi qu'il vient d'être rappelé); 2° la chétotaxie des 1^{er}, 2^e, 3^e, 4^e et 6^e tergites troncaux est identique à celle qu'on observe chez les *Pauropus* et *Allopauropus*, mais celle du 5^e en diffère: au lieu de porter une rangée antérieure de 6 soies et une postérieure de 4 soies comme chez ceux-ci, ce tergite a une rangée antérieure de 6 soies, une rangée postérieure de 4 soies et, entre les 2 rangées, une paire de soies latérales insérées en avant des trichobothries IV; pareille disposition n'a été signalée chez aucun autre Pauropode. La chétotaxie du pygidium, si elle est correctement décrite, ne paraît pas être non plus celle d'un *Pauropus*, ni d'un *Allopauropus*. Pour être fixé sur le statut de l'animal, il faudra étudier à nouveau les types.

Il est difficile aussi de faire entrer *Pauropus novae-hollandiae* dans le genre *Pauropus* ou dans tout autre genre de Pauropodes: en effet, sur le sternum pygidial de cet animal, qui n'est connu qu'au stade à 9 pp., HARRISON n'a observé que 2 paires de soies: les soies postérieures b_1 et les soies antérieures b_3 ; or, les seuls Pauropodes qui présentent semblable chétotaxie pygidiale sont les *Polypauropus*²; mais *P. novae-hollandiae*, dont le rameau anten-

¹ Abréviations: pp. = paire de pattes locomotrices; ad. = adulte (individu à 9 pp.); l. = larve; sexe?, stade? = sexe, stade non reconnus.

² Ce genre n'est connu que par 4 formes: *P. Duboscqi* Remy d'Europe et d'Afrique, *P. D. var. inflatiscetus* Remy, d'Europe, d'Afrique et d'Australie (voir ci-après), *P. Legeri* Remy de Corse et sa var. d'Afrique (Côte-d'Ivoire); sur le sternum pygidial de ces animaux sont insérées: 1° une paire de soies postérieures b_1 qui d'ailleurs, contrairement à ce qui a lieu chez les autres Pauropodes, sont assez en avant du bord postérieur et assez loin des bords latéraux, et non pas tout près des bords postéro-latéraux du sternum comme cela a lieu chez tous les autres Pauropodes; 2° plus en avant encore une paire de soies que j'ai assimilées aux latérales (b_2) des autres Pauropodes quand j'ai décrit *P. Duboscqi*, bien qu'elles soient relativement beaucoup plus loin des bords latéraux qu'elles ne le sont chez tous les autres Pauropodes; lorsque j'ai signalé la présence de *P. Legeri* var. en Côte-d'Ivoire, j'ai pensé qu'il faut plutôt considérer ces phanères comme des soies b_2 .

naire sternal ne porte qu'un seul globule au lieu de deux comme celui des *Polypauropus*, ne fait certainement pas partie de ce dernier genre; d'autre part, les seuls phanères que HARRISON signale sur le tergum pygidial sont une paire de styles et une paire de longues soies, tandis que chez les autres Pauropodes à 9 pp., on observe sur le tergum pygidial une paire de styles et 3 paires de soies (4 paires chez *Allopauropus argentinensis* Hansen et aussi, semble-t-il, chez "*Pauropus*" *causeyae* Starling); là encore, l'espèce australienne s'écarterait considérablement des autres Pauropodes. Mais l'étude de HARRISON est-elle complète? Un nouvel examen du matériel de Broken Bay s'impose.

M. le Professeur O. W. TIEGS, de l'Université de Melbourne, a eu l'obligeance de me faire parvenir une petite collection de *Pauropidae*, faite par lui en Australie sud-orientale. Cette collection renferme 18 individus; 15 ont pu être étudiés; je les ai répartis entre 5 formes dont une nouvelle.

1. *Stylopauropus pedunculatus* Lubbock f. typ.

Melbourne: jardin, sous des détritux végétaux en décomposition, 1 l. à 8 pp. sexe? L'animal m'a paru identique aux spécimens européens dont la plaque anale est du type danois (HANSEN 1902, Pl. I, fig. 1f).

L'espèce a une très vaste répartition géographique: Europe (Danemark, Angleterre, Belgique, France y compris Corse, Allemagne, Suisse, Italie, Yougoslavie, Roumanie), Algérie (d'Alger à Philippeville et de la Méditerranée à Batna), Indochine (Sud-Annam).

2. *Stylopauropus brito* Remy

Melbourne: sous une pierre, 1 ♂ ad. long de 0,40 mm.

Cet animal n'avait encore été rencontré qu'en France: 2 ad. et 1 l. à 8 pp. en Bretagne (défilé de Poulancré, Côtes-du-Nord) et 1 ad. dans les serres du Jardin des Plantes de Paris.

Jusqu'à présent, je l'avais considéré comme une var. de *S. pedunculatus*, mais j'estime maintenant que ces deux formes diffèrent suffisamment l'une de l'autre pour reconnaître à chacune le statut d'espèce.

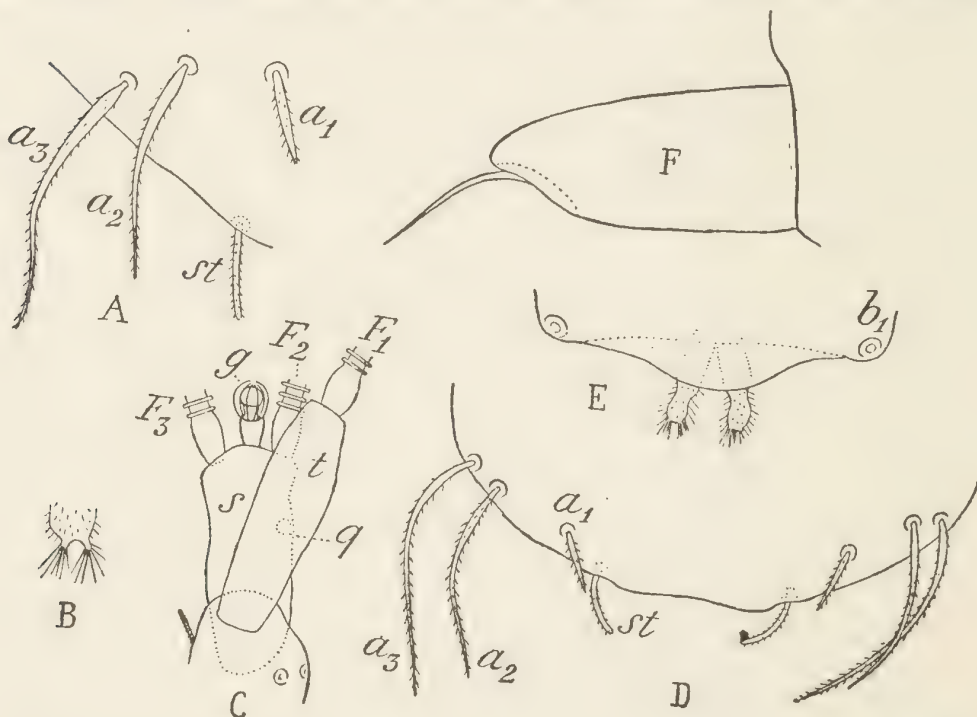
Le rameau antennaire tergal est 3 fois 1/2 aussi long que large chez le spécimen de Melbourne, 7 fois chez les *S. pedunculatus* typ. Les styles et la plaque anale de l'animal australien sont identiques à ceux des exemplaires bretons (types).

3. *Stylopauropus Tiegsi* n.sp.

Belgrave (Victoria): 1 ♂ ad. long de 0, 70 mm., 1 l. à 6 pp. longue de 0, 47 mm.

I. ADULTE.—TÊTE.—Longueur des organes temporaux à peu près égale à leur écartement minimum. A la 4e rangée transversale de poils tergaux, les submédians a_1 et les intermédiaires a_2 épais, claviformes, velus, les sublatéraux a_3 grêles, amincis vers l'extrémité distale, annelés; les a_1 égaux à leur écartement, légèrement plus courts que les a_2 qui sont égaux aux $3/4$ des a_3 et bien plus courts que la longueur des organes temporaux; les a_2 sont insérés plus près ($3/4$) des a_3 que des a_1 , l'intervalle, a_1a_2 étant le double de l'écartement des a_1 .

ANTENNES.—Au 4e article de la hampe, le poil tergal p égal à 1 fois $4/5$ le poil sternal p' et aux $3/4$ du rameau tergal t ; celui-ci, presque 4 fois aussi long que large, est égal aux $2/5$ de son flagelle



EXPLICATION DE LA FIGURE 1.

A à E, *Stylopauropus Tiegsi* n. sp., Belgrave. A et B, ♂ ad.—A, Région postéro-latérale gauche du tergum pygidial.—B, Région distale d'une corne de la plaque anale (schéma).—C, D et E l. à 6 pp.—C, Rameaux de l'antenne gauche, face tergale.—D, Région postérieure du tergum pygidial. E, Région postérieure du sternum pygidial.—F, *Pauropus silvaticus* Tiegs ♂ ad. (déterminé par TIEGS). Pénis droit, face antérieure.

et à un peu plus de la $1/2$ de la hampe; le rameau sternal s , égal à 1 fois $2/3$ son poil sternal q , est un peu plus court ($9/10$) que le rameau tergal; sa région postéro-distale très peu tronquée; ses 2 flagelles presque égaux ($10/11$), le plus court égal aux $5/7$ du flagelle du rameau tergal; le pédoncule du globule g , un peu aminci vers l'extrémité proximale, est égal à la largeur de l'organe, elle-même plus petite que celle du rameau tergal.

TRONC.—Au 5e tergite, 2 rangées de 6 poils; les 2 poils de la rangée postérieure du 6e tergite beaucoup plus courts que leur écartement, égaux aux $2/3$ des soies pygidiales a_2 . Trichobothries de la 3e paire à pubescence courte et grêle; leur axe aminci progressivement à partir de la région moyenne, la région distale devenant filamenteuse. Au tarse des pattes de la dernière paire, le poil proximal est égal aux $3/8$ de la longueur de l'article.

PYGIDIUM.—*Tergum*.—Soies faiblement pubescentes; les a_1 subcylindriques, amincies rapidement vers l'extrémité distale, égales au $1/4$ environ de leur écartement; soies a_2 et a_3 très effilées; les a_2 , égales à 2 fois $1/2$ les a_1 et aux $3/4$ des a_3 , sont insérées plus près de celles-ci que des a_1 , l'intervalle a_1a_2 étant les $3/11$ de l'écartement des a_1 . Styles grêles, cylindriques, annelés, très légèrement arqués l'un vers l'autre, égaux aux a_1 , leur écartement plus petit que celui de ces dernières.

Sternum.—Soies b_1 très effilées, égales à 2 fois les soies a_2 ; pas de b_2 ni de b_3 . Plaque anale velue, divisée par une encoche médiane pointue, profonde, en 2 lobes divergents, beaucoup plus longs que larges; la région antérieure de chacun de ces lobes est subrectangulaire, la région postérieure subovale; l'extrémité postérieure de chacun est prolongée par 2 tiges minces, très courtes, portant une touffe de longs poils.

II. LARVE.—TÊTE.—Organes temporaux un peu plus courts ($5/6$) que leur écartement minimum. Aspect des poils tergaux de la 4e rangée transversale comme chez l'adulte; mais les a_2 sont les $4/5$ des a_3 , et l'intervalle a_2a_3 n'est que les $3/5$ de l'intervalle a_1a_2 qui est le triple de l'écartement des a_1 .

ANTENNES.—Poils p et p' comme chez l'adulte; rameaux subégaux; le tergal, 3 fois $1/3$ aussi long que large, est égal à la $1/2$ de son flagelle; le sternal, 2 fois $1/2$ aussi long que large, est égal à environ 1 fois $4/9$ son poil sternal; sa région postéro-distale très peu tronquée; ses 2 flagelles subégaux ($10/11$), le plus court

égal aux $6/7$ du flagelle du rameau tergal; son globule comme chez l'adulte.

TRONC.—Les 2 poils de la rangée postérieure du dernier (5e) tergite égaux à presque le $1/3$ de leur écartement. Les trichobothries III comme chez l'adulte. Au tarse des pattes de la dernière paire, le poil proximal est égal au $1/3$ de l'article.

PYGIDIUM.—*Tergum*.—Comme chez l'adulte, sauf que les a_2 sont égales à 3 fois les a_1 .

Sternum.—Soies b_1 très effilées, égales à 1 fois $2/3$ les soies a_2 ; pas de b_2 ni de b_3 . Plaque anale comme chez l'adulte; son extrémité postérieure porte des corps étrangers et n'a pu être étudiée convenablement.

AFFINITÉS.—On ne connaît que 5 *Stylopauropus* authentiques: *S. brito* Remy, *S. pedunculatus* Lubbock, *S. p. brevicornis* Remy, tous trois cités plus haut, *S. pubescens* Hansen d'Europe (des Iles-Britanniques à la Corse et à la Roumanie) et *S. Beauchampi* Remy de l'Est de la France (Ain).³

On distinguera aisément *S. Tiegsi* de ces 5 formes en remarquant que, chez lui, la région postéro-distale du rameau antennaire sternal est beaucoup moins échancrée, le rapport longueur des soies pygidiales a_1 sur écartement de ces soies beaucoup plus petit et la plaque anale beaucoup plus profondément échancrée que chez les autres; c'est de *S. brito* que l'animal paraît se rapprocher le plus, mais les caractères des styles permettent de séparer facilement les 2 espèces: tandis que ces phanères sont cylindriques et égaux aux a_1 chez la forme australienne, ils sont claviformes et n'atteignent que le $1/5$ des a_1 chez l'autre; en outre, les 2 processus de la plaque anale sont beaucoup plus larges chez la première que chez la seconde.

4. *Pauropus Huxleyi* Lubbock var. *lanceolatus* Remy

Melbourne: jardin, sous des détritux végétaux en décomposition, 1 ad. ♂.

Répandu en Europe (Finlande, Danemark, Angleterre, France, Allemagne, Suisse). Le spécimen de Melbourne est en mauvais état, ses antennes mal orientées, la plupart de ses phanères absents. J'ai pu cependant constater que les styles et la plaque anale sont tout à fait semblables à ceux du type.

³ Pour des raisons indiquées ailleurs (REMY, 1941), je ne puis tenir compte des animaux nord-américains décrits par HILTON sous les noms de *S. digitus*, *locatus*, *simplus*, *oregonensis*, *dawsoni*, *alaskensis*, *globulus*, ni de celui, d'Amérique du Nord également, que COOK a nommé *S. atomus*.

5. *Pauropus silvaticus* Tiegs

Sans indication de station, 1 ad. ♂ (déterminé par TIEGS). Belgrave (Victoria), 9 ad. (5 ♂, 4 ♀).

Ce Pauropus est très voisin de *P. furcifer* Silvestri; on l'en distinguera immédiatement en examinant les pénis (leur pied non compris): chez *P. furcifer*, chaque pénis présente généralement une région basilaire à contour trapézoïdiforme, se continuant distalement par une partie subcylindrique terminée en pointe (REMY, 1935, fig. 5, c); tout à fait exceptionnellement (cas des spécimens du Vigan; REMY, 1947, fig. 1, d), le contour de l'appendice est triangulaire; chez *P. silvaticus*, par contre, les bords latéraux du pénis sont subparallèles sur leurs 2/3 proximaux, le contour du 1/3 distal de l'organe devenant subtriangulaire avec sommet arrondi.

En étudiant le spécimen déterminé par TIEGS, j'ai fait les observations suivantes:

Le globule distal de l'antenne est presque sessile; son diamètre est égal à celui du rameau antennaire tergal.

Au tergum pygidial, les soies a_1 , sont égales aux 5/8 environ de leur écartement, et aux 5/7 des soies a_2 , qui sont elles-mêmes les 7/10 des soies a_3 ; les a_2 sont insérées plus près des a_3 que des a_1 , l'intervalle a_1a_2 dépassant un peu la 1/2 de l'écartement des a_1 . Styles pointus, arqués (convexité du côté sagittal), égaux à la 1/2 environ de leur écartement, qui est les 3/4 de celui des soies a_1 . Au sternum pygidial, les soies b_2 sont égales aux soies pygidiales a_2 .

6. ?*Allopauropus* sp.

Sans indication de station: 3 individus en très mauvais état, stade? sexe?, longs de 0, 30 à 0, 40 mm.

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AUSTRALIAN OPILIONES

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Figs. 1-44.

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The Australian Opilionid fauna is but poorly known. Fifty-nine species have now been recorded, including the seven new species described in the present paper. Unfortunately, all the work to date has been done by overseas workers who have relied on preserved material, accompanied by very little field data. Hence it is not surprising to find that a considerable amount of confusion has arisen through the failure to consider numerous significant factors, especially those pertaining to the pronounced sexual dimorphism occurring in a large percentage of the Australian species.

The present paper is based mainly on the collections in the National Museum of Victoria, kindly forwarded to me for examination by the Director, Mr. R. T. M. Pescott, and supplemented by further material collected over the last two years by Mr. R. A. Dunn, of Melbourne. I am indebted to Professor V. V. Hickman, of Hobart, Tasmania, for valuable information on the related Tasmanian fauna, and for supplying the material from which *Paranuncia gigantea* has been re-described.

The present collection is probably more comprehensive than any previously studied, and fortunately a considerable series of both sexes of a number of species are available. Perhaps the most important result embodied in this paper is the establishment of a new subfamily, Megalopsalinae of the Phalangiidae. This subfamily probably includes all the *Palpatores* known from Australia. It is remarkable that the presence of a distinctly pectinate pedipalp tarsal claw should have been overlooked in all previous descriptions, as this character is undoubtedly the most distinctive one used to separate the subfamilies of the Phalangiidae.

In addition to the species described below, I have examined male specimens of *Megalopsalis serritarsus* Sor. from New South Wales, and a number of immature Phalangiidae from Western Australia. In all cases, the pedipalp tarsal claw was strongly pectinate. Professor Hickman informs me that the pedipalp claw of *Pantopsalis tasmanica* Hogg is also pectinate. As it is now

necessary to separate the Australian species previously placed in *Pantopsalis* from the New Zealand species, I have established *Spinicrus* n.gen., into which are placed all the Australian species. It is certain that in at least the two genera *Spinicrus* n.gen. and *Megalopsalis* Roewer, the males are characterized by extremely large spiculate chelicerae, while those of females are small and smooth.

Results obtained from the study of the nunciaeform triaenonychids in the collection demonstrate the need for caution in following the present tendency to use tarsal segmentation as a diagnostic generic character. Three instances are recorded below in which the number of tarsal segments of leg I of the female differs from that of the male of the same species, namely *Paranuncia gigantea* Roewer, *P. ingens* Roewer and *Nunciella tuberculata* n.sp. Hickman (1939) has previously drawn attention to a similar condition with *Nuncia unifalcata* (Enderlein).

Order OPILIONES

Suborder PALPATORES Thorell

Family PHALANGIIDAE Simon

Subfamily Megalopsalinae nov. subfam.

Thoracic tergites clearly defined by transverse grooves. Abdominal tergites usually clearly defined, occasionally fused. Corona analis absent. Openings of stink-glands clearly visible from above. Coxae I-IV without marginal rows of granules. Maxillary lobes of legs II directed obliquely across the anterior margin of the genital operculum. Basal segment of chelicerae normally with an anteriorly directed spine on the ventral surface; cutting edges of the fingers armed with both large and small teeth. Pedipalps slender, unarmed; terminal claw of tarsus well developed and strongly serrate below. Legs long and slender; femora I-IV without nodules. Secondary sexual characters usually abundant, strongly developed in chelicera, legs and cephalothoracic carapace.

The three genera recorded from Australia may be separated as follows:

1. Patella of pedipalp with a prominent apophysis—*Megalopsalis* Roew.
- Patella of pedipalp without apophysis—2.
2. Chelicera of male strongly spiculate, at least twice the length of the body—*Spinicrus* n.gen.
- Chelicera of male smooth, not exceeding the length of the body—*Nodala* n.gen.

Genus *MEGALOPSALIS* Roewer, 1923*Megalopsalis hoggi* (Pocock) 1902

Figs. 5-8.

1902 *Macropsalis hoggi* Pocock, Proc. Zool. Soc. London, II, pp. 398-399.1923 *Megalopsalis hoggi* (Pocock) Roewer, Die Weberknechte der Erde, pp. 867-868.

In his original description of *Megalopsalis hoggi*, Pocock appears to have confused two species. The so-called female specimens were probably males of the species described below as *Spinicrus camelus* n.sp. The male specimen is retained as *Megalopsalis hoggi* (Pocock), and a description is now given of the female. *M. hoggi* is relatively widely distributed, records listed below extending the range from Victoria to South Australia.

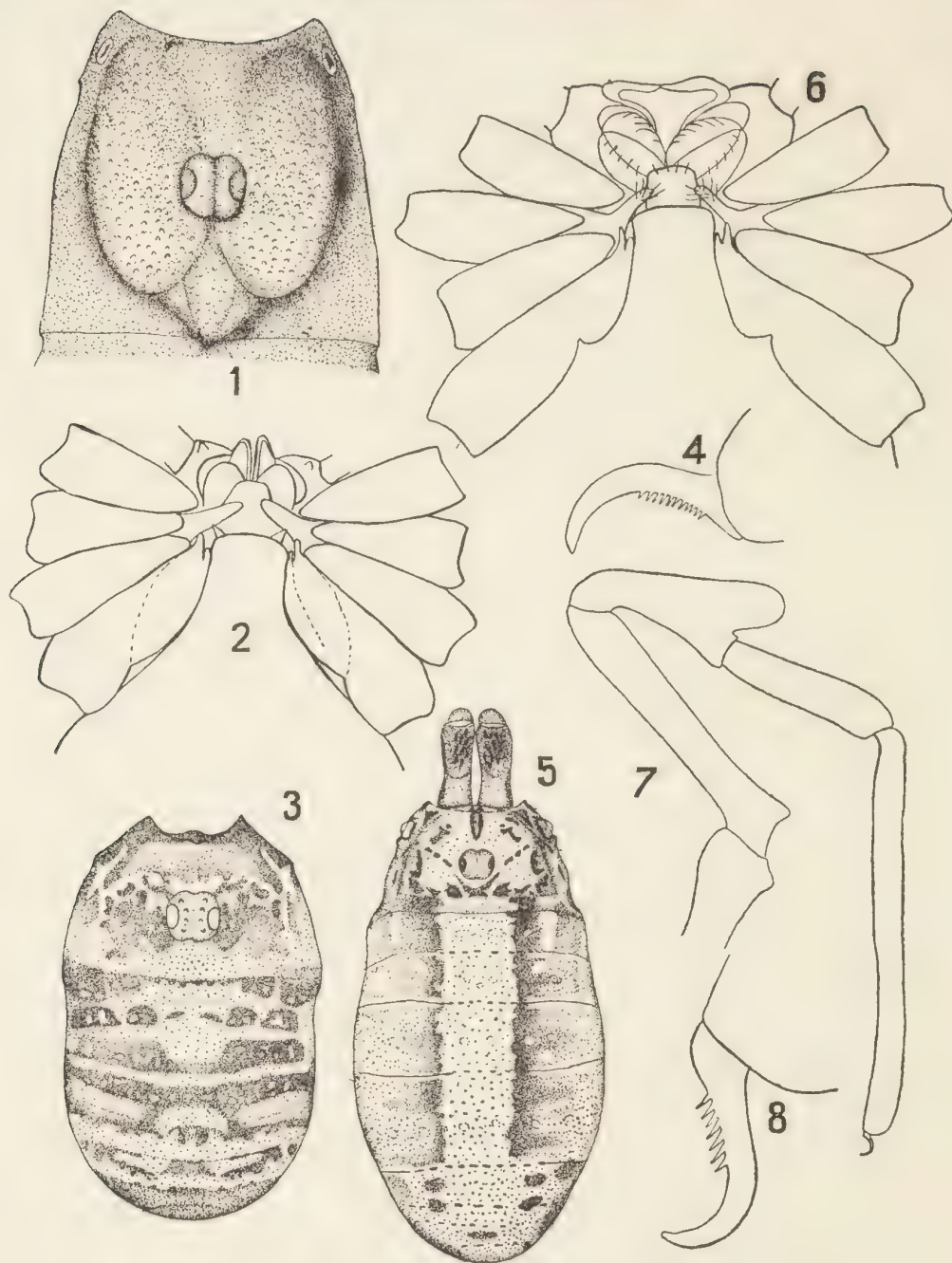
Female.

Colour. Cephalothoracic carapace greyish-brown marked with dark-brown as in Fig. 5. Dorsal surface of abdomen with a broad grey median band margined with dark-brown fading to greyish-brown along the lateral margins. Body below grading from light yellowish-brown to silvery-white. Legs light yellow with a number of dark-brown areas. Basal segment of the chelicerae with a number of dark-brown spots on the disto-dorsal surface, otherwise chelicerae light-yellow.

Body. Eyemound spherical, smooth, slightly canaliculate, set twice its diameter from the anterior margin of the carapace. Carapace smooth, surface anterior to the eyemound level, but the extreme anterior margin sloping steeply down to the chelicerae. Abdominal tergites and sternites clearly defined by shallow transverse grooves. Mouthparts as in Fig. 6. Maxillary lobes of coxae II broad basally, but more slender distally; directed obliquely across the anterior margin of the genital operculum. Genital operculum widening anteriorly, reaching the anterior margin of coxae III.

Chelicerae. Small and smooth. Basal segment slender, slightly constricted medially; proximo-ventral process small and rounded. Second segment slightly longer than basal segment. Inner margins of fingers lined with small uneven denticulations.

Pedipalps. As in Figs. 7, 8. Slender, slightly longer than body, unarmed. Femur sharply curved up from the proximal region, where the ventral surface is produced down as a sharp elbow. Disto-dorsal patellar process broadly rounded, almost half the



Figs. 1-4. *Spinicrus camelus* n.sp.

- Fig. 1. Dorsal view of cephalothoracic carapace of male.
 Fig. 2. Antero-ventral portion of body of male.
 Fig. 3. Dorsal view of body of female.
 Fig. 4. Pedipalp tarsal claw of male.

Figs. 5-8. *Megalopsalis hoggi* (Pocock)

- Fig. 5. Dorsal view of body of female.
 Fig. 6. Antero-ventral portion of body of female.
 Fig. 7. Pedipalp of female.
 Fig. 8. Pedipalp tarsal claw of female.

length of the tibia. Tarsus almost twice the length of the tibia. Tarsal claw slender, armed below with a single median row of from 6 to 8 sharp teeth.

Legs. All segments, including coxae, smooth, without denticulations or spines, but sparsely covered with short black setae.

Measurements in mms.—

Body: length 4.90, width 2.24

	Cox.	Troch.	Fem.	Pat.	Tib.	Met.	Tars.	Total
Leg I	1.03	0.29	2.63	0.68	2.42	1.43	5.00	13.48
Leg II	0.84	0.28	4.76	0.67	4.03	1.44	14.00	26.03
Leg III	0.83	0.24	2.08	0.63	1.78	1.48	4.44	11.48
Leg IV	1.04	0.24	3.74	0.73	2.53	3.22	8.00	19.50
Pedipalp		0.29	1.33	0.73	1.00	—	1.38	4.73
Chelicera: basal 1.29, second 1.46								2.75

Types. Holotype male, damaged specimen in British Museum; Allotype female, National Museum of Victoria, Melbourne.

Localities. The original male specimen was collected by H. R. Hogg at Macedon, Victoria. Further localities are: Golden Square (south of Bendigo), under stone on mullock heap, coll. F. G. Elford, September 16, 1947 (allotype); Ashbourne, S.A., in leaf mould, coll. J. T. Salmon; Myopongs, S.A., under bark, coll. J. T. Salmon; Sandy Creek, S.A., coll. A. N. Burns, August 28, 1947.

Genus SPINICRUS nov.

Eyemound normal, slightly canaliculate, set from two to three times its diameter from the anterior margin of the carapace. Cephalothoracic carapace of male spiculate, of female smooth. Abdomen of both male and female smooth, soft, segmentation defined by shallow transverse grooves. Chelicera of female short and smooth, not as long as body; chelicera of male long and spiculate, at least twice the length of body. Pedipalp of both male and female slender, spicules and apophyses absent; pedipalp tarsal claw strongly pectinate. Legs long and slender, strongly denticulate in male.

Genotype *Pantopsalis tasmanica* Hogg, 1910.

It is highly probable that on re-examination of the type specimen of *P. continentalis* Roewer, this species will also be placed in *Spinicrus*.

Spinicrus camelus n.sp.

Figs. 1-4, 9-10.

Male.

Colour. Cephalothoracic carapace black, but lateral margins pinkish-white. Eyemound black with a reddish area along the median line. Both tergites and sternites with a broad transverse band of dark chocolate-brown. A median dorsal pair of longitudinal dark-brown bands extend from the anterior margin of

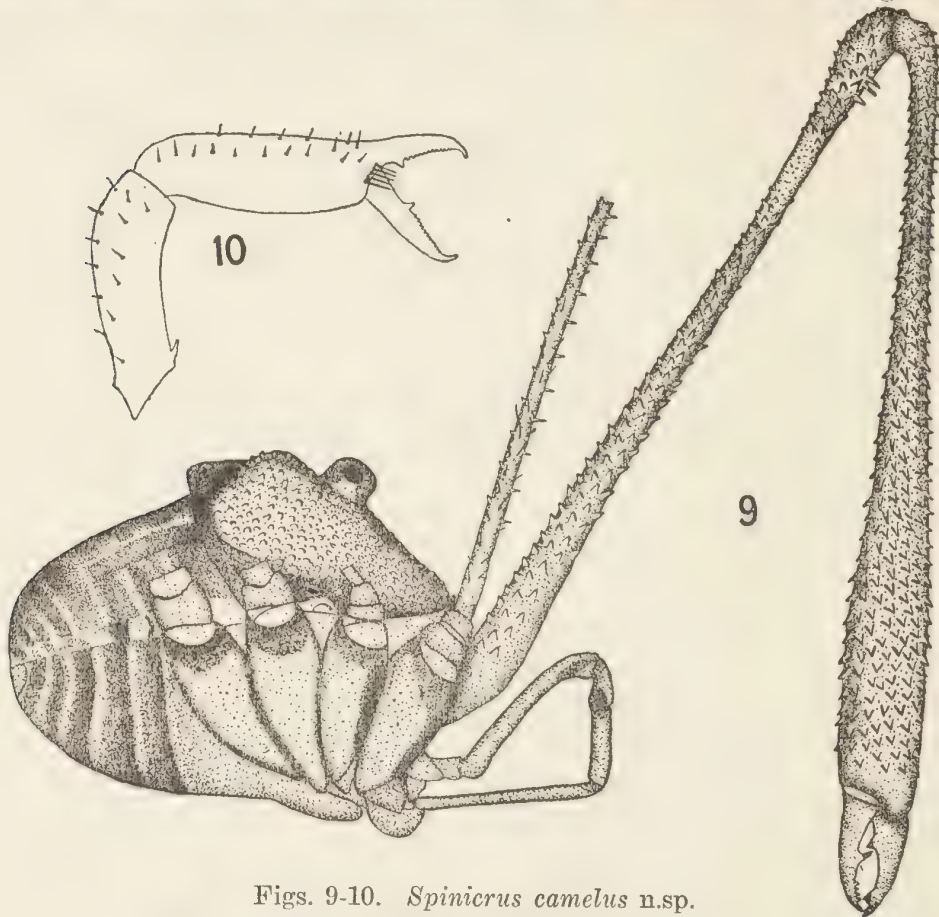
Figs. 9-10. *Spinicrus camelus* n.sp.

Fig. 9. Lateral view of male.

Fig. 10. Inner lateral view of chelicera of female.

(Figs. 9 and 10 drawn to the same scale.)

the abdomen to almost halfway. Genital operculum and anterior sternites yellow. Chelicerae blackish-brown, sub-distal area of the basal segment and fingers pale-yellow. Pedipalp light-yellow but reddish at the base. Coxae of legs pale-yellow except for dark-brown distal surface. Legs mainly dark-brown but with a few yellow bands.

Body. Eyemound rounded apically, but rising directly from the carapace, smooth, slightly canaliculate, set three times its diameter from the anterior margin of the carapace. Cephalothoracic carapace sclerotic, uniformly and finely granulate; sloping steeply down in front of the eyemound and extending up behind the eyemound to form a pair of large humps, between which there is a further sharp median ridge (Figs. 1, 9), rising in height but narrowing in width posteriorly to form a sharp peak jutting over the first tergite. Openings of the stink-glands clearly visible on the lateral margins of the carapace above coxae I. Abdomen soft, segmentation distinguished only by means of transverse rows of small setae and bands of dark-brown. Genital operculum squat, extending to posterior margin of coxa II. Mouthparts as in Fig. 2. Maxillary lobes of coxa II relatively broad, sub-triangular, twice as long as width at base.

Chelicerae. As in Fig. 9. Three times the length of body, both segments uniformly and strongly denticulate. Basal segment gradually narrowing from the proximal region but becoming stouter at the distal extremity. Second segment slender proximally but becoming uniformly stouter distally until twice as wide as the base of basal segment. Fingers well developed, crossing at tips when closed. Fixed finger with one strong tooth on the inner surface at one third and a further similar tooth at almost three-quarters, followed by a few smaller teeth. Movable finger with a strong tooth at halfway, followed by a number of small teeth on the distal third.

Pedipalps. Slender, almost as long as body, without apophyses. Tarsal claw small, pectinate below with a single row of 11-12 small even teeth on the proximal half (Fig. 4).

Legs. Coxae smooth, without granules. Femur with a prolateral row of sharp, fine, widely spaced small denticulations and a retro-lateral row of similar but much smaller denticulations. Femora II-IV with four rows of small denticulations. Remaining segments free from denticulations. Tibia III with nine and tibia IV with two false articulations.

Measurements in mms.—

Body: length 7.98, width 3.91								
	Cox.	Troch.	Fem.	Pat.	Tib.	Met.	Tars.	Total
Leg I	2.05	0.54	8.00	1.48	5.90	8.48	9.89	36.34
Leg II	2.10	0.59	13.56	1.58	14.42	4.90	31.67	68.82
Leg III	2.25	0.55	5.89	1.27	6.50	8.75	11.48	36.69
Leg IV	2.25	0.56	8.98	1.46	9.75	10.46	20.05	53.51
Pedipalp		0.52	1.85	0.68	1.10	—	2.46	6.61
Chelicera: basal 9.10, second 11.56								20.66

Female.

Colour. Dorsal surface of body patterned with silvery-white and blackish-brown as in Fig. 3. Ventral surface yellowish-white but brown along the lateral margins of the abdomen and distal surfaces of coxae I-IV. Chelicera yellow but with some brown patches on the dorsal surface. Pedipalps and legs banded with brown and light-yellow.

Body. The modifications found on the cephalothoracic carapace of the male absent, carapace smooth and only slightly sclerotic. Eye mound rounded and only slightly canaliculate, with a single row of small granules above each eye and removed from the anterior margin of the carapace by almost twice its diameter. Abdomen soft and smooth, both tergites and sternites faintly demarcated by transverse grooves. Genital operculum extending to the posterior margin of coxa II. Maxillary lobe of coxa II as in male.

Chelicerae. As in Fig. 10. Small and smooth, not quite the length of the body. Basal segment with a small, sharp, forwardly directed process on the proximo-ventral surface. A strong black tooth on the inner surface of the fixed finger at one third is followed by a single line of small denticulations. Movable finger with a similar arrangement but the large tooth at almost half-way. Tips sharply bent and cross when closed. A small comb of 5-6 small setae lines the inner proximal margin of the fixed finger.

Pedipalps. As in male. Tarsal claw with a single row of from 13-14 sharp, even teeth along the proximal half.

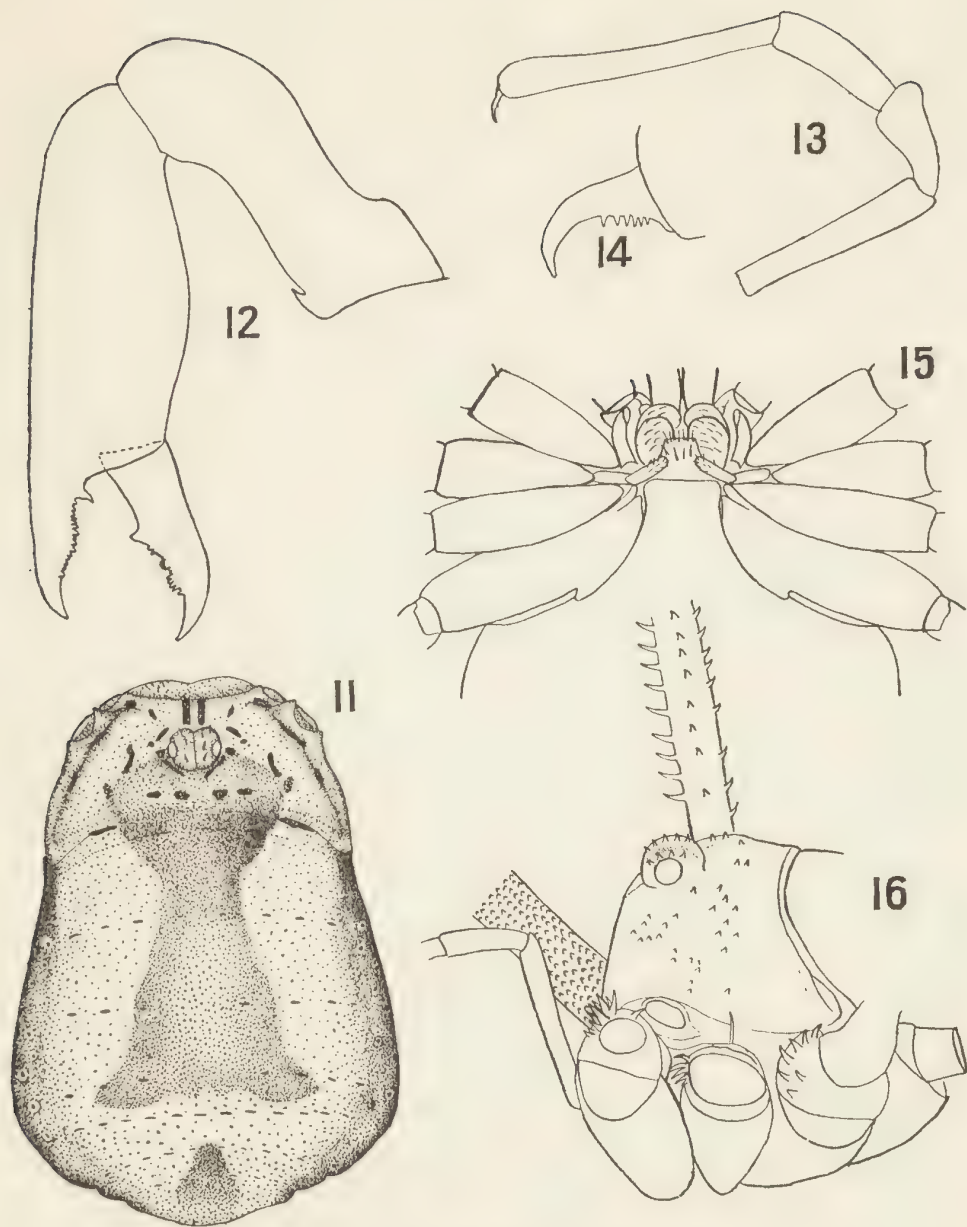
Legs. Coxae smooth, without granules. Femora I and II armed with a few small denticulations but legs otherwise smooth.

Measurements in mms.—

	Body: length 4.28, width, 2.80							
	Cox.	Troch.	Fem.	Pat.	Tib.	Met.	Tars.	Total
Leg I	1.16	0.51	3.00	0.89	3.06	2.83	6.43	17.88
Leg II	1.42	0.53	7.92	1.25	7.10	3.69	22.43	44.34
Leg III	1.53	0.51	4.10	1.05	3.76	4.45	8.49	23.89
Leg IV	1.82	0.56	4.20	0.83	4.22	2.73	10.48	24.84
Pedipalp		0.48	1.20	0.53	0.72	—	1.64	4.57
	Chelicera: basal 1.34, second 1.69							
								2.03

Types. Male holotype, female allotype, and paratypes in the collection of National Museum of Victoria.

Locality. Numerous specimens collected at Tubrabucca, N.S.W. Coll. R. T. M. Pescott and A. N. Burns, January, 1948.



Figs. 11-16. *Spinicrus stewarti* n.sp.

- Fig. 11. Dorsal view of body of female.
- Fig. 12. Outer lateral view of chelicera of female.
- Fig. 13. Pedipalp of female.
- Fig. 14. Tarsal claw of pedipalp of female.
- Fig. 15. Antero-ventral portion of body of female.
- Fig. 16. Latero-dorsal view of anterior portion of the body of male.

Spinicrus stewarti n.sp.

Figs. 11-16.

Male.

Colour. Cephalothoracic carapace dark-brown but pale-brown at the bases of the spicules and infused with white at each posterior corner. Abdomen above with a broad median dark-brown band extending to about two thirds, where the surface is silvery-white. Ventral surface of the abdomen and coxae dull-white, relieved by scattered patches of yellow-brown. Basal segment of the chelicera with a dark-brown patch on the distodorsal surface but otherwise yellow-brown. Second segment a darker brown but with a small white patch on the distal surface. Pedipalp banded with white and brown. Legs dark-brown but with several light-brown patches.

Body. Eyemound spherical and with a row of from three to five strong spicules along each side of the median groove; set its own diameter from the anterior margin of the carapace. Cephalothoracic carapace armed with numerous spicules as in Fig. 16; sloping steeply down in front of the eyemound to the chelicera, where the anterior margin is entire. Abdomen smooth and soft; segmentation indicated by faint transverse grooves. Genital operculum widening distally and extending to the posterior margin of coxa I. Maxillary lobes of coxae II longer than wide in the ratio of 4:1, directed obliquely forward anterior to the genital operculum.

Chelicerae. Finely spiculate (Fig. 16), basal segment not quite as long as second segment, the length of both segments being two and a half times that of the body. The inner surface of the fixed finger is armed with a strong triangular tooth at one third and a further similar tooth at two thirds; between these a strong median tooth on the inner surface of the movable finger fits when the fingers are closed. A comb of small black setae is present along the inner distal margin of the second segment.

Pedipalps. Slender, apophyses absent, slightly longer than the length of the body; covered on all segments with short black setae, but otherwise smooth. Tarsal claw below with a single row of six sharp teeth restricted to the proximal half.

Legs. Coxae smooth but for a sparse covering of short black setae. Trochanters I-IV with a bunch of sharp spines on the anterior surface. Femora I-IV strongly and evenly spined. Patella I covered with spines, those on the anterior surface being strongest. Remaining segments without spines.

Measurements in mms.—

Body: length 5.52, width 3.24

	Cox.	Troch.	Fem.	Pat.	Tib.	Met.	Tars.	Total
Leg I	1.80	0.48	6.75	1.48	6.48	7.44	8.50	32.93
Leg II	1.74	0.48	10.50	1.25	10.73	4.32	28.00	57.02
Leg III	1.90	0.47	4.84	1.00	4.22	4.21	14.90	31.54
Leg IV	2.38	0.48	8.73	1.26	7.04	5.52	16.46	41.87
Pedipalp		0.52	0.49	1.44	0.76	—	2.13	5.34
Chelicerae: basal 5.94, second 7.25								13.19

Female.

Colour. Dorsal surface of body as in Fig. 11. Ground colour creamy-white with two black lines in front of the eyemound and other scattered black patches as in figure. Median hourglass-shaped band and lateral margins of the abdomen blackish-brown. Ventral surface of abdomen silvery-white with dark-black intersternal lines. Coxae and trochantera of legs with numerous small brown patches, remaining segments of legs and pedipalps banded with yellow and brown. Chelicerae mainly yellow but overlaid with black reticulations.

Body. Eyemound spherical, slightly canaliculate, smooth, set almost twice its diameter from the anterior margin of the carapace. Cephalothoracic carapace poorly sclerotised, smooth, sloping sharply down to the chelicerae in front of the eyemound. Abdomen soft, tergites defined by transverse lines of small black indentations. Genital operculum extending to the posterior margin of coxae II, widening distally. Mouthparts and maxillary lobes of coxae II as in Fig. 15.

Chelicerae. As in Fig. 12. Short, as long as body. Basal segment with a dorsal notch and a short spinous process on the proximo-ventral surface. Second segment relatively stout; fixed finger with a strong tooth on the proximal surface followed by a row of small even denticulations; movable finger similar, but the proximal large tooth fits beyond that of the fixed finger when closed.

Pedipalps. As in Figs. 13, 14; tarsal claw armed below with a row of from 6 to 8 small sharp teeth.

Legs. All coxae smooth. Trochantera I-III with each a number of small sharp spines on the prodistal surface. Legs otherwise smooth.

Measurements in mms.—

Body: length 7·0, width 3·75								
	Cox.	Troch.	Fem.	Pat.	Tib.	Met.	Tars.	Total
Leg I	1·48	0·49	4·15	0·95	4·48	3·55	9·00	24·10
Leg II	1·45	0·48	8·00	1·25	7·75	3·02	23·00	44·95
Leg III	1·75	0·47	3·98	1·23	4·00	3·99	10·00	25·42
Leg IV	2·45	0·49	7·00	1·48	6·09	4·35	14·50	36·36
Pedipalp	·	0·55	1·50	0·59	0·78	—	1·95	5·37
Chelicera: basal 1·2, second 2·0								3·20

Types. Holotype male and allotype female in National Museum of Victoria; paratypes in Canterbury Museum, Christchurch, N.Z.

Locality. Mount Buffalo, Victoria, where large numbers have been collected by Mr. H. C. E. Stewart, of Melbourne, after whom I have the pleasure of naming this species. The largest series was collected from the bole of a Snow Gum (*Eucalyptus paucifolia*) during December, 1947.

Genus **NODALA** nov.

Eyemound normal, canaliculate, set its own diameter from the anterior margin of the carapace. Cephalothoracic carapace smooth. Body smooth, tergites I-V of male fused into a scute, otherwise clearly demarcated by transverse grooves. Chelicerae of both male and female smooth, short, not as long as body. Pedipalps relatively stout, but without apophyses, spiculate in male. Legs slender, long and smooth.

Genotype *Nelima dunni* Forster, 1948.

This species was provisionally placed in the subfamily *Lio-
buninae* until a more extensive survey of the Australian Palpa-
tores could be made. It is now evident that it should be placed in
the *Megalopsalinae*.

Suborder **LANIATORES** Thorell
Family **TRIAENONYCHIDAE** Sörensen
Subfamily **Triaenonychinae** (Pocock)

KEY TO THE AUSTRALIAN GENERA

- | | |
|--|-----|
| 1. Eyemound smooth and rounded. | 2. |
| — Eyemound conical. | 4. |
| — Eyemound with a median spine. | 5. |
| — Eyemound with a hook on the anterior margin. | 11. |
| 2. Eyemound rising from the anterior margin of the carapace. | |

Nunciella Roewer.

- Eyemound removed from the anterior margin of the carapace. 3.
- 3. Scutal segmentation clearly defined by transverse grooves.
Pedipalp weakly spined; distal region of femur swollen. *Lomanella* Pocock.
- Scutal segmentation not defined by transverse grooves.
Pedipalp strongly spined; femur normal. *Neonuncia* Roewer.
- 4. Eyemound removed from the anterior margin of the carapace. Scutal areas faintly defined by transverse grooves; areas I-V each with a median pair of spines. *Paranuncia* Roewer.
- Eyemound rising from the anterior margin of the carapace. Scutal areas not defined by transverse grooves but closely covered with granules. *Conoculus* n. gen.
- 5. Eyemound rising from the anterior margin of the carapace. 6.
- Eyemound removed from the anterior margin of the carapace. 8.
- 6. Spines present on scutum. 7.
- Spines absent from scutum; scutal areas clearly defined by transverse grooves. Median spine on eyemound directed anteriorly. *Perthacantha* Roewer.
- 7. Areas II and III each with a median pair of spines. Median spine of eyemound directed forward. Anterior margin of carapace smooth. *Monocanthobunus* Roewer.
- Only area III with a median pair of spines. Median spine of eyemound erect. Anterior margin of carapace armed with strong spines. *Heteronuncia* Roewer.
- 8. Scutal areas defined by transverse grooves and spined. 9.
- Scutal areas not defined by transverse grooves and smooth. *Parattahia* Roewer.
- 9. Scutal spines limited to area III. 10.
- Scutal areas I-IV each with a median pair of spines; those of area III largest. *Jenolanicus* Roewer.
- 10. Tarsus I with five segments. *Equitius* Simon.
- Tarsus I with six to seven segments. *Monoxyomma* Pocock.
- 11. Tarsus II with five segments. *Callihamus* Roewer.
- Tarsus II with six or more segments. *Calliuncus* Roewer.

Genus NUNCIELLA Roewer, 1928

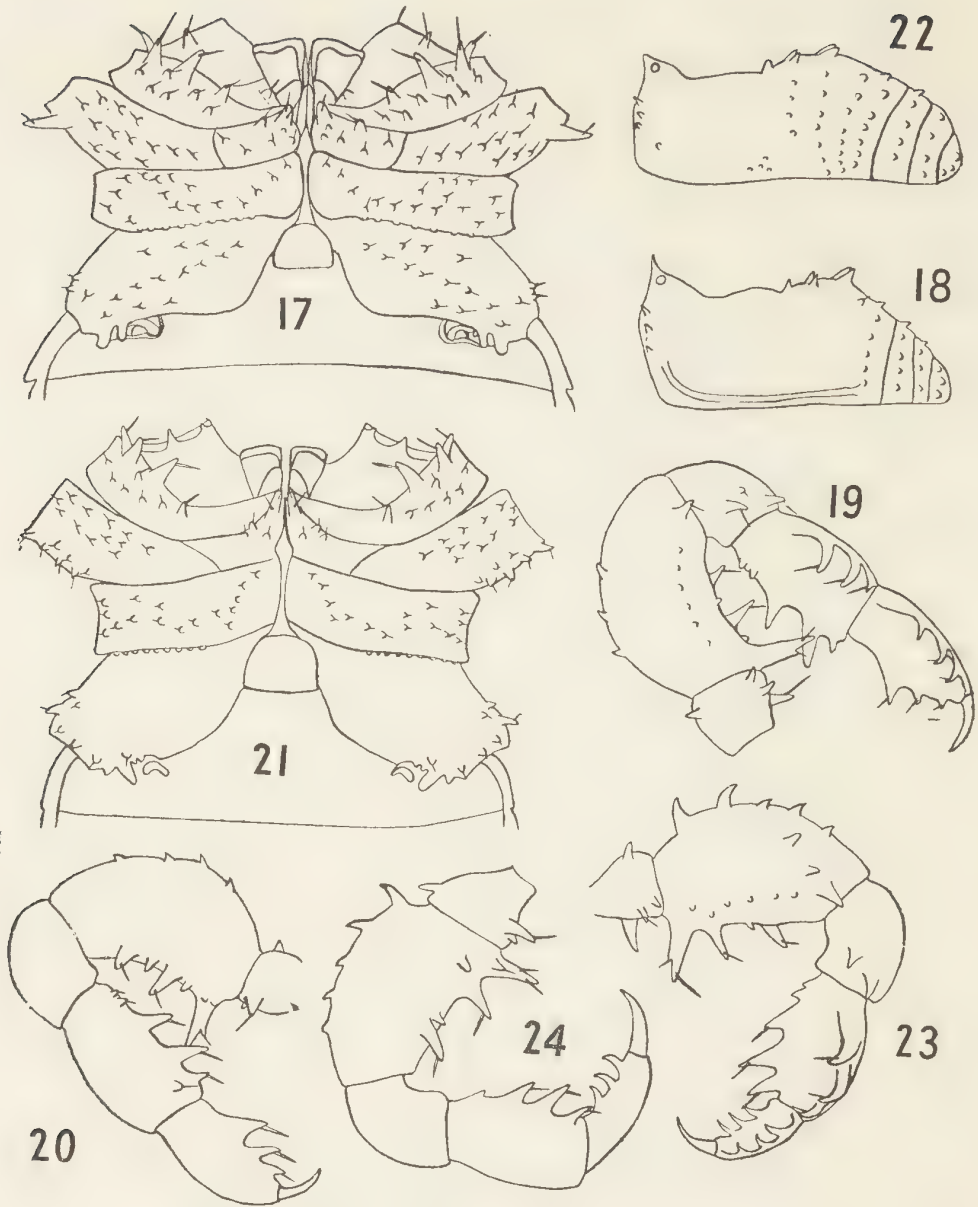
Nunciella tuberculata n.sp.

Figs. 25-32

Male.

Colour. Mainly dark-brown; black reticulations extend from the anterior margin of the carapace to behind the eyemound. A median black band extends from immediately behind the eyemound back to the posterior margin of the abdomen, broad anteriorly but narrowing posteriorly. Coxae to tibiae of legs, chelicerae and pedipalps reticulate.

Body. Eyemound set almost half its length from the anterior margin of the carapace, low and smoothly rounded. A pair of small sub-marginal spines are placed in line with, and anterior to, the lateral margins of the eyemound, while the anterior margin of the carapace is armed with a small median spine and a curved



Figs. 17-20. *Paranuncia gigantea* Roewer

Fig. 17. Antero-ventral portion of body of male.

Fig. 18. Lateral view of tergum of male.

Fig. 19. Inner view of pedipalp of male.

Fig. 20. Outer view of pedipalp of male.

Figs. 21-24. *Paranuncia ingens* Roewer

Fig. 21. Antero-ventral portion of the body of male.

Fig. 22. Lateral view of tergum of male.

Fig. 23. Inner view of pedipalp of male.

Fig. 24. Outer view of pedipalp of male.

Female.

Colour. As in male.

Body. Eyemound as in male, but set no more than one-third of its length from the anterior margin of the carapace. Anterior margin of the carapace with five spines placed as in male but much smaller. The antero-lateral pair not modified (Fig. 26). Remaining body characters as in male.

Chelicerae. Shorter than male (Fig. 26), two-thirds the length of body. Basal segment strongly bent, disto-dorsal surface swollen. Rounded boss on outer proximal surface wanting. Second segment with a sharp spine on the inner dorsal surface.

Pedipalps. Much weaker than male (Figs. 31, 32). Spination differing as follows: Proximo-ventral spine of femur unevenly bifurcate, third ventral spine of male reduced to a small tubercle; tibia with one proximal and three distal spines on the inner ventro-lateral margin, while those on the outer ventro-lateral margin are greatly reduced in size; tarsus with two median-placed tubercles on the inner ventro-lateral surface.

Legs. Coxae as in Fig. 27. Only moderate-sized spines present on the prodistal surface of coxa, retrodistal surface of coxa II and prodistal surface of coxa IV. Tarsal formula 3, 10-11, 4, 4. Disto-tarsus of leg I two-segmented, leg II four-segmented.

Measurements in mms.—

	Body: length 5.55, width 3.90							
	Cox.	Troch.	Fem.	Pat.	Tib.	Met.	Tars.	Total
Leg I	1.52	0.48	1.94	0.89	1.44	1.93	1.23	9.43
Leg II	1.68	0.53	2.43	0.88	2.04	2.38	2.49	12.43
Leg III	1.42	0.53	1.53	0.83	1.48	2.28	1.23	9.30
Leg IV	1.96	0.65	2.74	1.23	2.03	3.24	1.29	13.14
Pedipalp		0.43	1.74	0.78	1.38	—	1.04	5.37
	Chelicera: basal 1.54, second 1.93							
								3.47

Types. Holotype male, allotype female and paratypes in the National Museum collection.

Localities. Diamond Creek, Victoria, coll. J. E. Dixon, August, 1925 (Type locality); Warburton, Victoria, coll. J. A. Kershaw, April 11, 1905; Kallista, Victoria, under logs, coll. A. N. Burns, September 18, 1946.

The spination of the pedipalps of this species differs considerably from both of the previously described Victorian species, *N. cheliplus* Roewer and *N. parvula* Roewer. The numerous structural characters which show sexual dimorphism in the above

described species, some of which have been used for specific criteria, indicate the need for a revision of previously described species.

Genus *PARANUNCIA* Roewer, 1914

1914. Roewer, C. Fr., Arch. Naturg., 80A (12), p. 108.
1923. Roewer, Die Weberknechte der Erde, pp. 605-606.
1931. Roewer, Zeitschr. f. wiss. Zool., 138 (1), p. 155.

Cephalothoracic carapace shorter than scutum. Eyemound conical, removed from the anterior margin of the carapace by not more than one-third of its width. Areas I-III of the scutum each with a median pair of spines. Scutal areas not distinguished by transverse grooves. Small spines present on the anterior margin of the carapace. Free tergites I-III each with a single transverse row of small even tubercles. Legs unarmed except for granulations. Calcanus much shorter than astragalus. Calcanus of leg IV of male notched below. Distitarsi of leg I two-segmented, leg II three-segmented. Tarsal formula of male 4, 9-12, 4, 4; female, 3, 9-12, 4, 4. Median prong of tarsal claws III and IV much stronger than lateral branches.

Genotype *P. gigantea* Roewer.

This genus was established by Roewer (1914) for *P. gigantea* from Tasmania. Roewer (1931) added a further species, *P. ingens* from Victoria. Numerous specimens of *P. ingens* were available for study in the present collection, and it is evident that a number of important characters had not been noted in the original description, the most important of these being the possession of four segments to tarsus I of the male, but only three in the female. Professor V. V. Hickman informed me that this is also the case with the Tasmanian *P. gigantea*, and most generously supplied me material from which the redescription of the species is given below.

Paranuncia gigantea Roewer, 1914

Figs. 17-20.

1914. *P. gigantea* Roewer, Arch. Naturg., 80A (12), p. 108.
1923. *P. gigantea* Roewer, Zeits. wiss. Zool., 138 (1), pp. 155-156.

Male.

Colour. Body and legs light chocolate-brown. Chelicerae and pedipalps yellow-brown, but covered with dark-brown reticulations.

Body. Eyemound removed a short distance from the anterior margin of the carapace, sloping evenly up to form an erect spine almost immediately above the eyes (Fig. 18). Anterior margin

of the carapace produced medially and at each outer margin of the chelicera to form three spines. The anterior margin of the carapace at each side of the eyemound is armed with a row of four erect spines. A well-defined ridge extends from each anterior corner of the cephalothoracic carapace along the lateral margins to area V. Areas I and II each with a median pair of small erect spines, area III with a median pair of larger spines, area IV with a median pair of small widely-spaced tubercles. Areas I-IV otherwise smooth. Area V and free tergites I-III with each a single transverse row of small tubercles. Sternites smooth except for a single transverse row of minute setose tubercles. Genital operculum smooth, wider at base than length in ratio of 3:2. Sternum as in Fig. 17. Maxillary lobes of coxae II produced anteriorly by a strong tubercle.

Chelicerae. Small. Basal segment constricted proximally, distal portion rounded; with a strong spine on the inner and a small spine on the median disto-dorsal surfaces. Dorsal surface of the second segment with a large proximal tubercle and numerous scattered small tubercles.

Pedipalps. As in Figs. 19, 20. Robust. Coxa below with a strong spine on the distal surface. Trochanter below with a strong median spine and two smaller spines on the inner surface, and a stout spine on the mid-dorsal surface. Femur armed below with a stout medio-proximal bifid spine, four spines along the lateral margin, the first and third being short, and a row of small granules along the inner margin extending to a strong spine rising from the latero-distal margin; dorsal surface with a line of four rather small spines. Patella with two large and one small spine on the inner surface, but otherwise smooth. Femur strongly concave below and armed along the outer margin with three spines, two strong and one small; these are preceded by two tubercles on the proximal surface; inner lateral margin with three strong spines. Tarsus concave below, armed along the outer margin with three spines of which the most proximal one is very broad at the base, inner margin with three uniform strong spines. Tarsal claw strong.

Legs. Coxae below as in Fig. 17. Coxa I with a strong bifid spine on the distal region of the proventral surface, followed by a large single spine at mid-way and smaller spine at three-quarters, remainder of the ventral surface with scattered tubercles. Coxa II with a strong spine on the retroventral surface and three lines of small tubercles on the ventral surface, and a transverse ridge on the dorsal surface which extends over the lateral margin of the

carapace. Coxae III and IV without spines but with numerous scattered tubercles on the ventral surface. Two flattened lobes extend from the sub-distal region of the retroventral margin of coxae IV to overlie the lateral portion of each spiracle. Trochantera, femora, patellae and tibiae granulate. Calcaneus distinct but much smaller than the astralagus. Calcaneus of leg IV deeply notched on the ventral surface. Distitarsi of leg I two-segmented, leg II three-segmented. Tarsal formula 4, 9-11, 4, 4.

Measurements in mms.—

Body: length 7.00, width 6.05

	Cox.	Troch.	Fem.	Pat.	Tib.	Met.	Tars.	Total
Leg I	1.76	0.68	4.08	1.32	2.73	3.18	2.54	15.29
Leg II	2.52	0.83	4.51	1.43	3.22	4.26	3.94	20.71
Leg III	2.06	0.62	2.51	1.43	2.36	3.52	2.16	15.66
Leg IV	2.42	0.93	3.52	1.52	3.14	5.51	2.22	19.26
Pedipalp		1.31	3.18	1.74	2.32	—	2.00	10.55
	Chelicera: basal 2.10, second 2.60							4.70

Female.

Characters as in male except as follows.

Pedipalp less robust, spines smaller but with similar distribution. Maxillary lobes of coxae II without a large tubercle on anterior surface. Calcaneus of leg I not notched below; tarsal formula 3, 9-12, 4, 4.

Measurements in mms.—

Body: length 8.03, width 6.76

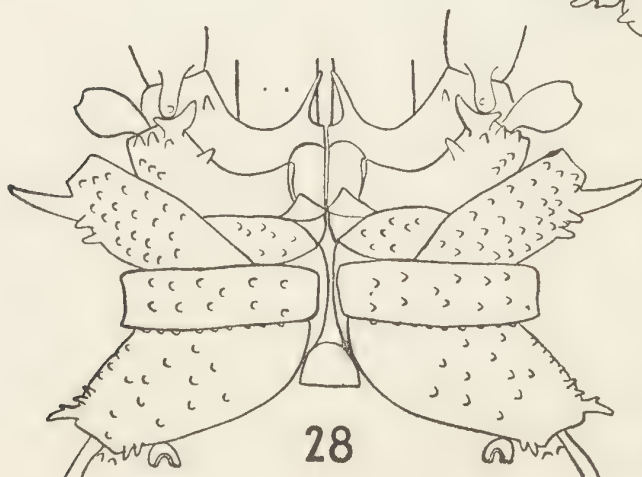
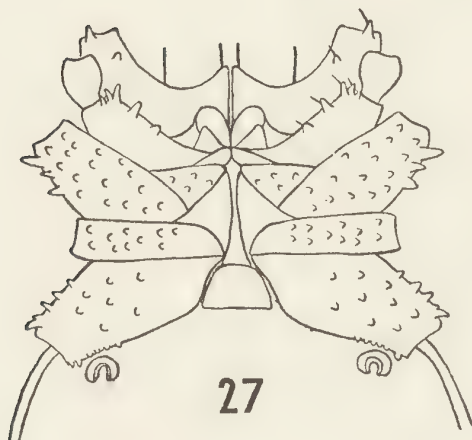
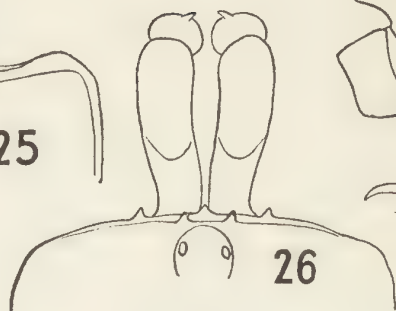
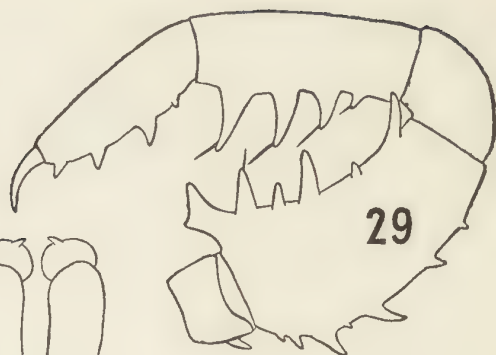
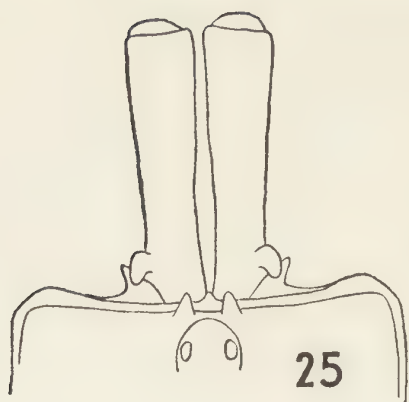
	Cox.	Troch.	Fem.	Pat.	Tib.	Met.	Tars.	Total
Leg I	1.70	0.78	3.02	1.27	2.63	3.32	1.63	14.35
Leg II	2.31	0.94	3.92	1.76	3.73	5.42	4.52	22.60
Leg III	1.96	0.93	3.23	1.52	2.68	4.29	2.33	16.94
Leg IV	2.34	1.23	4.06	1.63	3.76	6.03	2.58	21.63
Pedipalp		0.63	2.76	1.38	1.93	—	1.61	8.31
	Chelicera: basal 1.80, second 1.96							3.76

Types. Coll. Roewer, Senckenberg Museum, Frankfurt a Main.

Locality. Tasmania.

Figs. 25-32. *Nunciella tuberculata* n.sp.

- Fig. 25. Antero-dorsal portion of cephalothoracic carapace and chelicerae of male.
 Fig. 26. Antero-dorsal portion of cephalothoracic carapace and chelicerae of female.
 Fig. 27. Antero-ventral portion of the body of female.
 Fig. 28. Antero-ventral portion of the body of male.
 Fig. 29. Outer view of pedipalp of male.
 Fig. 30. Inner view of pedipalp of male.
 Fig. 31. Outer view of pedipalp of female.
 Fig. 32. Inner view of pedipalp of female.



Paranuncia ingens Roewer, 1931

Figs. 21-24

1931. *P. ingens* Roewer, Zeitschr. f. wiss. Zool., 138 (1), p. 155.*Male.*

Colour. Body chocolate-brown, but with a light-brown patch outside the median paired spines of areas I-III. Legs dark-brown. Pedipalps and chelicerae light-brown but closely covered with blackish-brown reticulations.

Body. Eyemound set back only slightly from the anterior margin of the carapace, sloping steeply, almost vertically, up from immediately just behind the anterior margin of the carapace and sloping gently back along the posterior surface so that the apex is slightly anterior to the eyes (Fig. 21). Anterior margin of the cephalothoracic carapace produced forward between the chelicerae to form a median spine and at each outer margin to form a further pair. Three sharp erect spines are present along the anterior margin of the carapace each side of the eyemound, while a further rather blunt small spine is placed in from the lateral margin above leg II. Cephalothoracic carapace separated from the scutum by a shallow groove, but scutum itself not divided by grooves. Areas I-III each with a median pair of relatively large recumbent spines, those of area III being strongest. Area I with a cluster of four small tubercles at each lateral margin; area II with a transverse row of tubercles which do not extend to the lateral margins as is found on areas III-V. Free tergites I-III each with a single transverse row of similar tubercles. Sternites each with a single transverse row of granulations. Genital operculum sparsely granulate, evenly rounded, wider than long in the proportion of 4:3. Maxillary lobe of coxa II produced anteriorly by an elongate blunt tubercle.

Chelicerae. Relatively weak. Basal segment with a strong setose spine on the inner disto-dorsal surface, and several smaller setose tubercles on the dorsal surface. Second segment with a row of three setose spines on the proximal half of the dorsal surface and a few small setose tubercles scattered on the disto-distal surface.

Pedipalps. As in Figs. 23, 24. Robust; coxa below with two spines on the distal margin, one lateral and the other median in position; trochanter with a large medio-ventral spine, followed by two smaller spines on the inner ventral margin; the dorsal surface unarmed except for a strong spine at two-thirds. Femur armed below with a strong spine on the proximal surface, followed by a

further slightly smaller spine on the outer ventral surface; a small spine at one-fifth with a further pair, one small and one large, at five-sevenths; on the inner ventral surface a row of small granules extends to a strong distal spine which is preceded by two smaller spines on the inner surface; a line of five spines extends along the dorsal surface, the proximal two being larger than the remaining three. Patella smooth except for a pair of strong spines on the distal half of the inner surface. Tibia strongly concave below; three strong spines along the inner and one weak and three strong spines along the outer ventro-lateral margins. Tarsus concave below, both inner and outer ventro-lateral margins with three strong spines. Tarsal claw strong.

Legs. Coxa I with a strong bifid spine on the pro-distal surface and a further strong single spine at almost midway, while a number of smaller tubercles are arranged as in Fig. 21. Coxa II with a row of small spines along the distal half of the retrolateral margin in addition to numerous small tubercles on the ventral surface. Coxa III without spines but covered below with numerous tubercles, and with a row of granules along the retrolateral margin. Coxa IV smooth except for a small spine near the prodistal surface and a few distoventral tubercles; retrodistal surface produced posteriorly into one small and a further large lobe which overhang the outer margin of the spiracle. Trochanter, femur, patella and tibia of all legs coarsely granulate. Calcaneus small but distinct; calcaneus of leg I deeply notched on the ventral surface. Distitarsal segments of leg I, two; leg II, three. Tarsal formula 4, 9-13, 4, 4.

Measurements in mms.—

	Body: length 8·10, width 6·68							
	Cox.	Troch.	Fem.	Pat.	Tib.	Met.	Tars.	Total
Leg I	1·65	1·00	3·05	1·53	2·68	3·62	1·53	15·06
Leg II	2·45	1·03	4·31	1·84	3·98	5·53	4·08	23·22
Leg III	2·51	1·00	3·12	1·53	2·58	3·96	1·94	16·64
Leg IV	2·74	1·26	4·51	1·64	3·41	5·52	2·53	21·61
Pedipalp		0·73	3·24	1·58	2·22	—	1·68	9·45
Chelicera: basal 2·08, second 3·12								5·20

Female.

As in male except as follows. Pedipalp not as robust as that of the male but spination similar. Granules absent from the retrolateral margin of coxa III. Maxillary lobe of coxa II not as well developed as male and distal tubercle absent. Genital operculum

smooth, wider than long in proportion of 5:3. Calcaneus of leg IV not notched below; distotarsal segments of leg I two-segmented and leg II three-segmented; tarsal formula 3, 10-12, 4, 4.

Measurements in mms.—

Body: length 8.23, width 6.08								
	Cox.	Troch.	Fem.	Pat.	Tib.	Met.	Tars.	Total
Leg I	1.52	0.88	2.66	1.42	2.53	3.21	1.52	13.74
Leg II	2.08	0.92	4.06	1.68	3.92	5.38	4.42	22.46
Leg III	2.43	0.98	3.42	1.52	2.41	3.94	1.80	16.50
Leg IV	2.83	1.02	3.92	1.71	3.42	5.51	1.68	20.09
Pedipalp		0.61	2.52	1.26	1.72	—	1.50	7.61
	Chelicera: basal 2.10, second 2.76							4.86

Type locality. Cockatoo, Victoria. Type in British Museum (Natural History), London.

Further localities. Dandenong Ranges (Roewer, 1931); Warburton, Vic., coll. J. A. Kershaw, April 11, 1905; Gippsland, Vic., coll. S. Butler; Diamond Creek, Vic., coll. J. E. Dixon, August, 1925; Ferntree Gully, Vic., coll. G. F. Hill, March 22, 1924; Kallista, Vic., coll. A. N. Burns, September 18, 1946.

Genus LOMANELLA Pocock, 1903

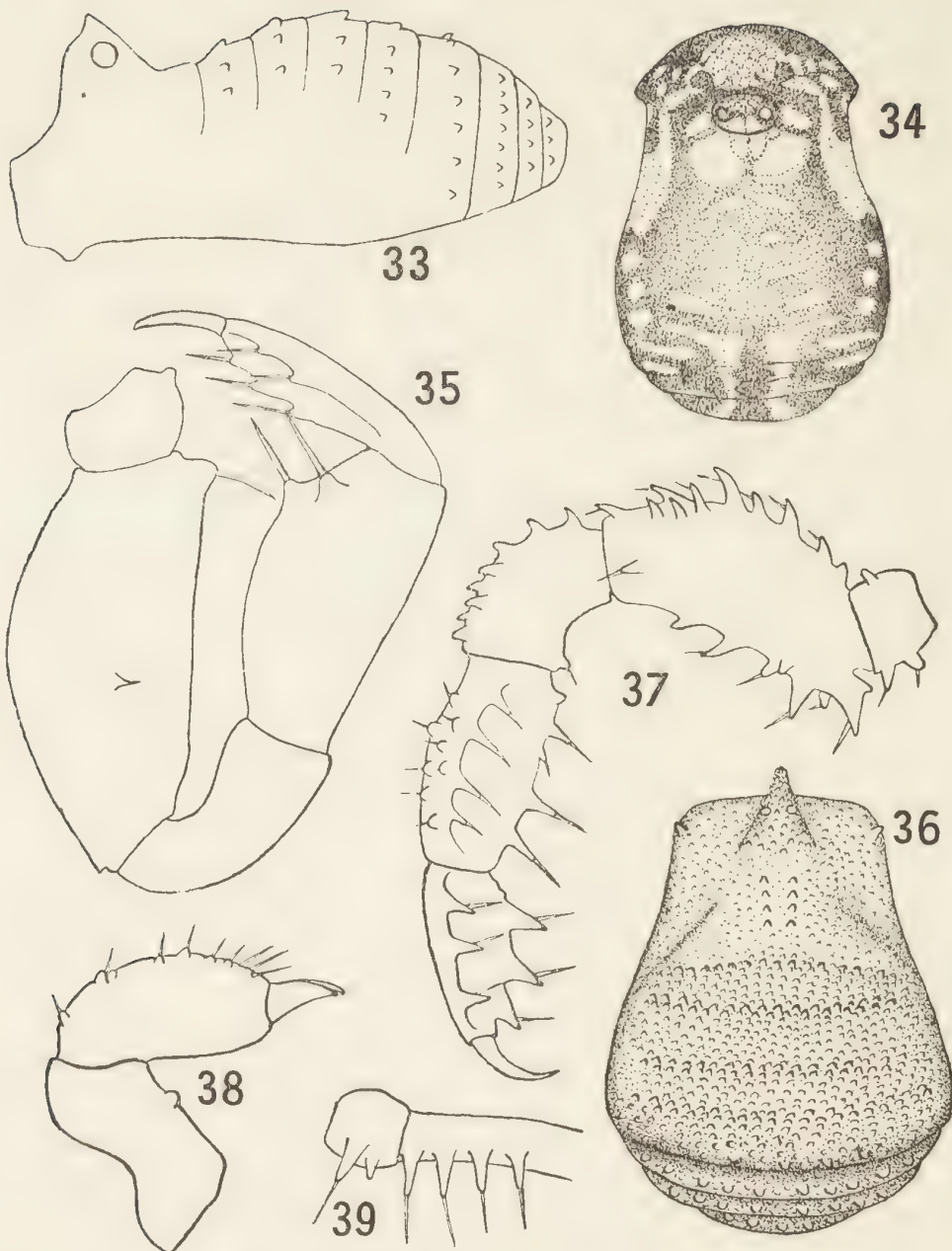
Lomanella kallista n.sp.

Figs. 33-35.

Male.

Colour. Dorsal surface of the body blackish-brown with a symmetrical pattern marked out in orange as in Fig. 34. Anterior surface of the eyemound and the antero-median area of the carapace covered by blackish-brown reticulations. Body below mainly orange-yellow but the posterior margins of the sternites and the distal surface of coxae I-IV blackish-brown. Pedipalp, chelicerae and legs dark-yellow, but covered with dark-brown reticulations.

Body. Eyemound bluntly conical, with a slight sub-apical concavity on the anterior surface; higher than wide in the ratio of 10:7; set its own width from the anterior margin of the carapace (Fig. 33). Cephalothoracic carapace smooth, anterior margin evenly rounded and produced out at each anterior corner to form a small lobe. Areas I-IV defined by broad transverse grooves, which do not reach the lateral margin. All areas with a single line of small setose granules which, except in area V, are restricted to the medial surface. Free tergites I-III as area V with a single transverse row of similar setose granules which extend to the



Figs. 33-35. *Lomanella kallista* n.sp.

Fig. 33. Lateral view of tergum of male.

Fig. 34. Dorsal view of the body of male.

Fig. 35. Outer view of pedipalp of male.

Figs. 36-39. *Conoculus asperus* n.gen., n.sp.

Fig. 36. Dorsal view of body of male.

Fig. 37. Inner view of pedipalp of male.

Fig. 38. Outer view of chelicera of male.

Fig. 39. Retrolateral view of trochanter and part of the femur of leg I of male.

lateral margins. Sternites smooth except for a single transverse row of minute setose granules. Genital operculum of triangular shape, wider at base than length in proportion of 7:9. Sternum very narrow.

Chelicerae. Small. Basal segment constricted proximally, disto-dorsal surface smooth but for a few small granules. Second segment with a line of small setose granules on the dorsal surface but otherwise smooth.

Pedipalps. As in Fig. 35. Trochanter small, almost twice as wide as long, with a small setose tubercle on the ventral surface. Femur swollen and smooth except for a small setose tubercle on the proximo-ventral surface and a small median spine on the inner surface. Patella smooth, relatively slender, slightly more than twice as long as the width at the widest portion. Tibia evenly ovoid, not concave on the ventral surface; armed with a pair of setose tubercles on the ventral surface at five-sixths of the distance from the proximal margin. Tarsus slender, concave below, and armed along the outer margin with three and along the inner margin with two setose tubercles. Tarsal claw strong.

Legs. All segments except metatarsi and tarsi granulate, ventral surface of femur IV strongly so. Calcaneus of all legs very small, much shorter than astralagus. Calcaneus of leg IV not notched below. Distitarsi of leg I of two segments, leg II of three segments. Tarsal formula 3, 5, 4, 4. Median prong of claws III and IV much stronger than side branches.

Measurements in mms.—

Body: length 4.59, width 2.29							
	Cox.	Troch.	Fem.	Pat.	Tib.	Met.	Tars.
Leg I	0.51	0.31	1.07	0.56	0.97	1.17	0.76
Leg II	1.02	0.31	1.78	0.76	1.53	1.94	1.37
Leg III	0.86	0.36	1.22	0.56	1.02	1.47	0.82
Leg IV	1.22	0.41	1.58	0.76	1.58	1.53	0.97
Pedipalp		0.26	1.27	0.61	1.07	—	0.97
Chelicera: basal 0.51, second 0.61							1.12

Type. Male holotype in the collection of the National Museum of Victoria, Melbourne.

Locality. A single specimen, collected by Mr. A. N. Burns at Kallista, Vic.

Remarks. This species is closely related to *L. raniceps* Roewer from Tasmania, but can be separated from the Tasmanian species by its much higher eyemound and the presence of strong granulations on the femur of leg IV.

Genus CONOCULUS nov.

Dorsal scute coarsely granulate, but without spines; areas I-V not defined by transverse grooves. Eyemound only slightly removed from the anterior margin of the carapace, evenly conical and directed slightly forward. Pedipalps robust, strongly spined. Coxae I and II strongly granulate, III and IV with both pro- and retrolateral rows of granules. Trochanter and femur of leg I with a prolateral row of strong setose tubercles. Calcaneus much smaller than astralagus. Tarsal formula 3, 6-7, 4, 4. Distotarsus of leg I two-segmented, leg II three-segmented. Side claws much smaller than median claw. Spiracles hidden. Sexual dimorphism only slight.

Genotype *C. asperus* n.sp.

Conoculus asperus n.sp.

Figs. 36-39.

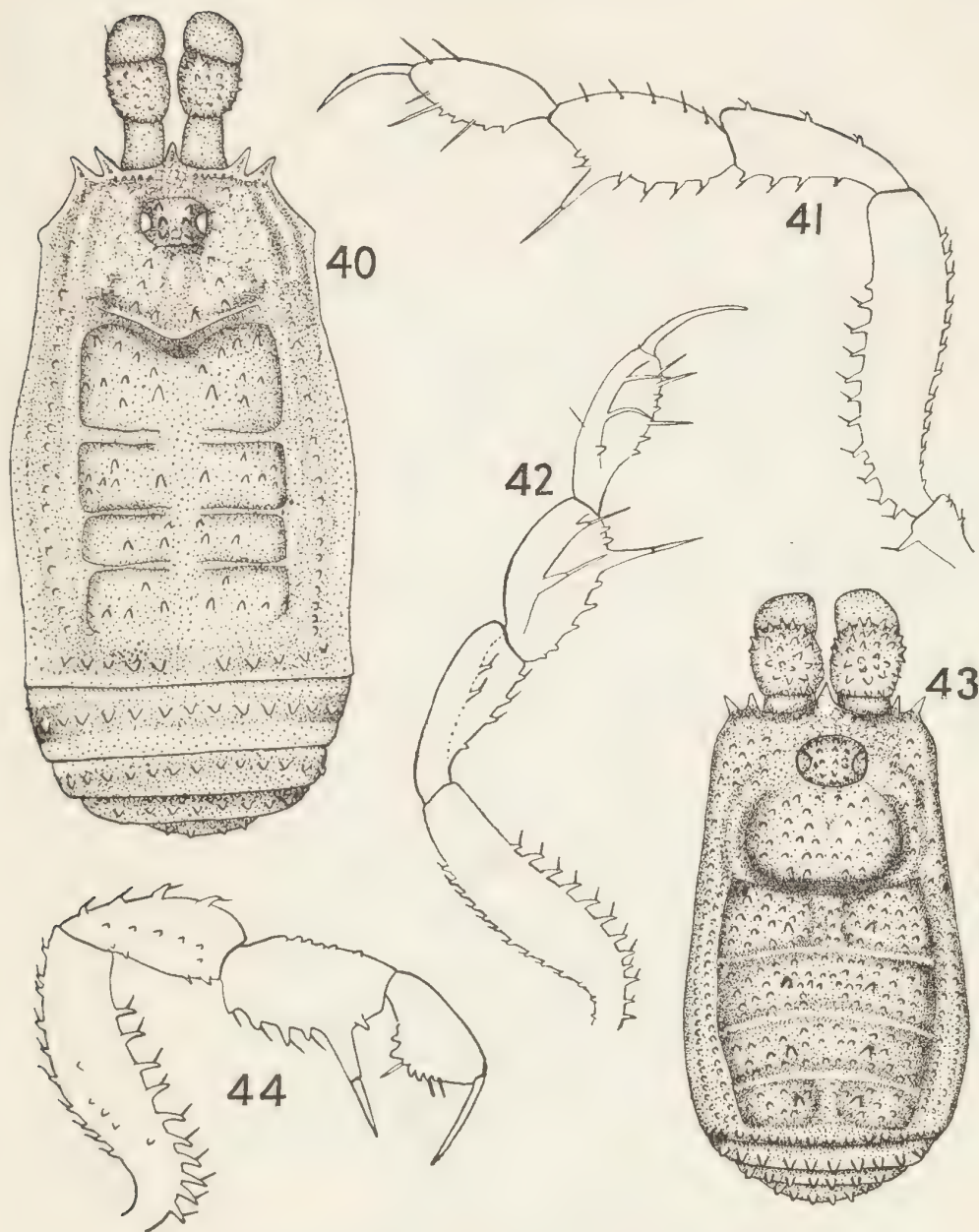
Male.

Colour. Body and appendages dark blackish-green.

Body. Eyemound set back from the anterior margin of the cephalothoracic carapace by no more than one-third of its width at the base, narrowing evenly to the apex and slightly directed forward; covered with strong granules (Fig. 36). Cephalothoracic carapace and areas I-V not separable by transverse grooves, but scutal area more coarsely granulated than cephalic area and position of the fused tergites defined by transverse rows of more large granulations. Four median pairs of large granules extend back immediately behind the eyemound, while a further large granule is present on the antero-lateral margin of the cephalothoracic carapace. Free tergites I-III each with a single transverse row of large granules. Sternites smooth except for a single row of small granules. Genital operculum covered with minute granules. Sternum narrow, rodlike.

Chelicerae. As in Fig. 38. Small; basal segment indented dorsally; smooth except for a small tubercle on the mid-ventral surface. Second segment squat, with a row of from three to four small tubercles along the dorsal surface.

Pedipalps. As in Figs. 37, 38. Trochanter with two ventral and one dorsal tubercles. Femur with a large obliquely clavate spine on the proximo-ventral surface followed by a further row of five spines, of which the second and fourth are large; inner surface smooth except for a single spine on the distal surface; median dorsal surface armed with a row of seven strong spines; inner



Figs. 40-42. *Euwintonius continentalis* Roewer

Fig. 40. Dorsal view of body.

Fig. 41. Outer view of pedipalp.

Fig. 42. Inner view of chelicera.

Figs. 43-44. *Dampetrus gracilis* n.sp.

Fig. 43. Dorsal view of body.

Fig. 44. Outer view of pedipalp.

dorsal surface with a row of three small spines at three-quarters. Patella with numerous tubercles on the dorsal surface and a single tubercle on the ventro-distal surface. Tibia deeply concave below and strongly tuberculate on the dorsal surface, with a row of four spines along both the inner and outer ventro-lateral surfaces. Tarsus concave below; smooth except for three strong spines along each of the ventrolateral margins. Tarsal claw strong.

Legs. Coxae I and II covered with small pustulate granules, but coxae III and IV with a row of similar granules at both the anterior and posterior margins, otherwise smooth. Ventral surface of trochanter of leg I with one large conical setose tubercle; femur with a proximal ventral row of four similar tubercles; tibia with a ventral row of three more slender tubercles (Fig. 39); legs otherwise sparsely granulate. Tarsal formula 3, 6-7, 4, 4. Distotarsus of leg I two-segmented, leg II three-segmented. Calcaneus minute.

Measurements in mms.—

	Body: length 2.33, width 2.13							
	Cox.	Troch.	Fem.	Pat.	Tib.	Met.	Tars.	Total
Leg I	0.40	0.19	0.68	0.33	0.54	0.53	0.38	3.05
Leg II	0.83	0.22	0.96	0.53	0.96	0.89	0.78	5.17
Leg III	0.68	0.23	0.73	0.43	0.70	0.78	0.43	3.98
Leg IV	0.74	0.24	1.04	0.43	0.88	1.18	0.64	5.15
Pedipalp		0.14	0.76	0.39	0.53	—	0.43	2.63
	Chelicera: basal 0.53, second 0.68							
								1.21

Types. Holotype male and paratypes, Dominion Museum, Wellington, New Zealand.

Locality. Glen Osmond, South Australia, under stones, coll. J. T. Salmon.

Family **ASSAMIIDAE** Sörensen

Subfamily **Dampetrinae** Roewer

Genus **DAMPETRUS** Karsch, 1880

Dampetrus gracilis, n.sp.

Figs. 43-44.

Colour. Entire body and appendages of a uniform yellow-brown, but the bases of granules on the dorsal surface of body blackish-brown.

Body. Dorsal scute longer than wide in ratio of 3:2. Eye-mound strongly granulate, wider than long in proportion of 11:7, set almost its longitudinal depth from the anterior margin of the carapace (Fig. 43). Cephalothoracic carapace strongly granulate, with a strong ridge running across immediately before the anterior

margin and separated behind the eyemound from area I by a deep curved transverse groove. Areas I-IV clearly distinguished by straight transverse grooves which only extend to a pronounced lateral longitudinal ridge which merges posteriorly with area V. Lateral ridge with a double row of granules. Areas I-IV closely and coarsely granulate, but each with a well separated median pair of small spines. Area V and free tergites I-III each with a single transverse row of small spines. Posterior sternites with a single transverse row of small granules; anterior sternites fused with coxae IV. Spiracle concealed beneath the postero-distal margin of coxa IV. Genital operculum very small, provided with a small emarginate lip. Sternum narrowly triangular.

Pedipalps. Slender, spination as in Fig. 44.

Chelicerae. Small. Disto-dorsal surface of basal segment swollen and strongly granulate. Second segment smooth.

Legs. Coxa IV large, more than twice the size of coxae I-IV. Coxa I with a smooth oblique notch on the antero-lateral margin, lined at each side with a row of granules, into which the trochanter of the pedipalp fits when at rest. Coxae II-IV closely granulate below and with a row of granules along the antero-lateral margin. Legs faintly granulate. Calcaneus very small. Tarsal formula 6, 6, 6, 7. Distotarsi of legs I and II both three-segmented. Tarsal claws smooth, apophyses absent.

Measurements in mms.—

	Body: length 4·23, width 2·11							
	Cox.	Troch.	Fem.	Pat.	Tib.	Met.	Tars.	Total
Leg I	1·05	0·29	2·06	0·64	1·34	2·30	1·06	8·74
Leg II	1·19	0·28	3·14	0·79	2·55	3·29	1·24	12·48
Leg III	1·10	0·31	2·54	0·58	1·75	2·70	1·39	10·37
Leg IV	2·45	0·49	3·44	0·93	2·50	3·94	1·70	15·45
Pedipalp		0·44	1·07	0·74	0·60	—	0·62	3·47
	Chelicera: basal 0·55, second 0·65							
	1·20							

Type. Holotype male and paratypes in collection of National Museum of Victoria, Melbourne.

Locality. Redcliffs, Victoria, collected by A. S. Cudmore, April 18, 1925.

Genus EUWINTONIUS Roewer, 1923

Euwintonius continentalis Roewer

Figs. 40-42.

1923. *E. continentalis* Roewer, Die Weberknechte der Erde, pp. 234-235.

Colour. General body colour yellow-brown, but dorsal surface lightly overlaid with blackish brown, which forms a reticulate pattern on the cephalothoracic carapace. Chelicerae yellow but the

granulations on the dorsal surface of the basal segment dark-brown. Pedipalps yellow but with dark-brown reticulations above. Coxae IV with black reticulations on the dorsal surface, legs otherwise pale-yellow.

Body. Dorsal scute longer than wide in the ratio of 9:7. Eyemound low, wider than long in proportion of 12:7, with a line of three small spines above each eye; set slightly less than its length from the anterior margin of the carapace (Fig. 40). Cephalothoracic carapace sparsely covered with large granules behind the eyemound where it is separated from area I by a deep, curved, transverse groove. Areas I-V separated by wide, shallow, transverse grooves which are terminated at each side by the strong lateral ridge which extends forward almost to the anterior margin of the cephalothoracic carapace and divided medially by a shallow longitudinal groove. A single row of small granules is present on the lateral ridges, while areas I-IV are sparsely covered with small spines, but with a median larger pair on each area. Free tergites I and II fused laterally with the dorsal scute and each armed with a single transverse row of small spines. Free tergite III with an anterior row of similar spines and also a more posterior row of small granules. Sternites each with a single transverse row of very small granules. Spiracle hidden beneath the postero-distal margin of coxa IV. Genital operculum smooth, anterior margin smoothly rounded. Sternum small, rodlike.

Pedipalp. Slender, spined as in Figs. 41, 42.

Chelicerae. Small. Basal segment with a strongly granulate disto-dorsal swelling, chelicerae otherwise smooth.

Legs. All coxae closely granulate, with a row of granules along the anterior margin. Remaining segments faintly granulate. Calcanes small; tarsal formula 6-8, 12-16, 6, 7. Distotarsi of leg I with three segments, leg II with four segments.

Measurements in mms.—

	Body: length 4.59, width 2.45							
	Cox.	Troch.	Fem.	Pat.	Tib.	Met.	Tars.	Total
Leg I	1.04	0.33	2.03	0.63	1.52	2.76	1.25	9.56
Leg II	1.23	0.44	3.74	0.94	3.03	3.14	2.75	15.27
Leg III	1.32	0.49	2.59	0.82	1.98	3.42	1.44	12.06
Leg IV	2.45	0.53	4.04	1.03	2.93	4.83	1.48	17.29
Pedipalp		0.32	0.83	0.83	0.48	—	0.45	2.91
	Chelicera: basal 0.73, second 0.78							
								1.51

This species was originally established by Roewer for a single male specimen collected at Winton, Queensland. A large col-

lection of both males and females was examined in the present collection from King River, Northern Territory, collected by W. McLennan about 1916. As Roewer's original description was brief and not accompanied by figures, I have amplified the description and added figures, which will assist in future identification.

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DEVONIAN FOSSILS FROM SANDY'S CREEK, GIPPSLAND, VICTORIA

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Plates II and III, Fig. 1.

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Fossils from Sandy's Creek, a branch of the Mitchell River, in the Parish of Nungatta, Gippsland, Victoria, were handed to the writer for description by Mr. W. Baragwanath of the Victorian Mines Department. The specimens were collected by Mr. J. G. Easton, Field Geologist, in 1927, and Fig. 1 is taken from a map prepared by him. The fossils herein described came from the localities he marked G 22 - 26, and the types have been lodged in the Victorian Mines Department Museum.

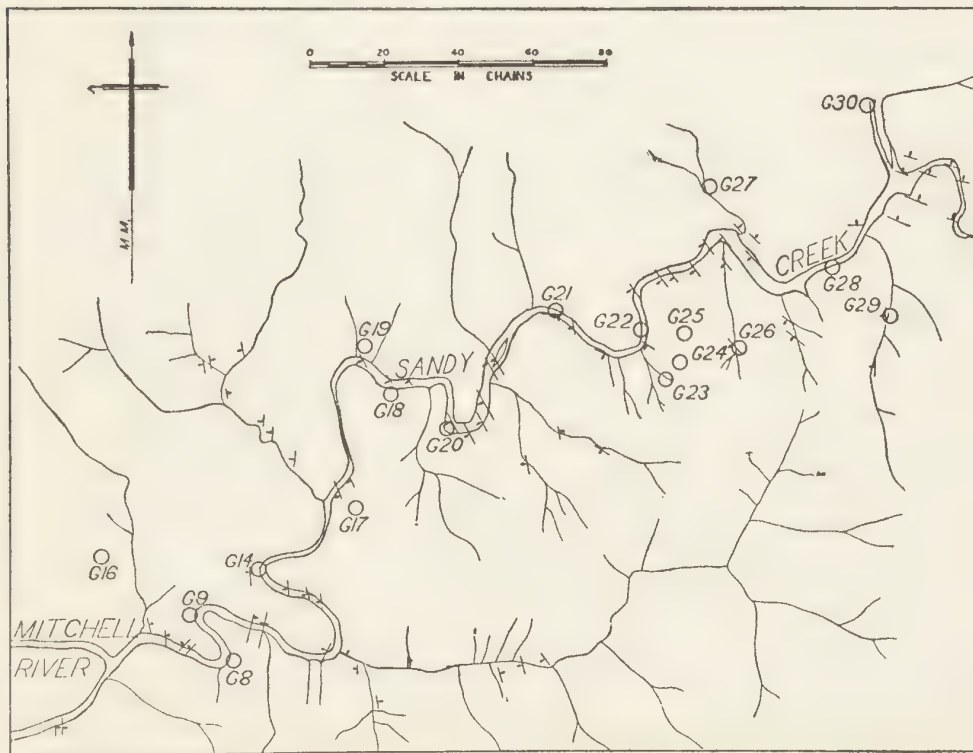


FIG. 1

Locality plan of part of Parish of Nungatta drawn from Mines Department map, originally prepared by J. G. Easton, Field Geologist.

MATRIX AND FACIES

The fossils consist mostly of casts and moulds in a sandstone so fine-grained that it looks like a mudstone, but is nevertheless arenaceous; the fracture is shaley. The colour is light brown, but patches of grey suggest that originally the rock was of a grey colour and has turned light brown through oxidation of ferruginous matter. Some of the rock is not quite decalcified, certain specimens retaining part of the original calcic matter of the shells; a number of the latter were treated with hydrochloric acid to clear them for study. Thus, originally, the bedrock was a grey calcareous arenaceous shale.

Specimens 27,188 and 27,190¹ are of coarser sandstone, and are characterized by the presence of great numbers of crinoid stem joints. They represent a change in facies, no doubt towards shallower waters. A couple of pieces of rock are crowded with a branching polyzoan, and other small facies differences have been noted.

The fossils from Sandy's Creek are of Bohemian (Konieprusy) type facies, i.e., inner off-shore, or waters of moderate depth. The Lower Devonian beds of the Lilydale and Killara districts are of this facies (Gill, 1939, 1942, 1945a, 1945b, 1949a, 1949b, 1949c). As is often the case with this type of facies, calcareous beds are developed. Etheridge described corals (1899) and determined shelly fossils (1902) from Sandy's Creek.

The rocks from Sandy's Creek have been affected by shearing movements as is shown by the distortion of the fossils. Skeats (1929, pp. 108-111) has discussed the tectonics of the area.

FAUNA

In the palaeontological collection studied, the following forms have been recognized:

PLANTAE

Frag. indet. of simple land plant of the *Hostimella* type.

ANTHOZOA

Casts of "*Lindstroemia*" type of solitary corals.

CRINOIDEA

Numerous stem joints and some pieces of stem.

POLYZOA

Acanthoclema flexuosa Chapman.

¹ Specimen numbers in this paper, unless stated otherwise, are registered numbers in the museum of the Victorian Mines Department.

BRACHIOPODA

Cariniferella alpha sp. nov.

C. beta sp. nov.

Conchidium polymitum sp. nov.

Eospirifer eastoni sp. nov.

Spirifer (?*Quadrifarius*) sp.

Protoleptostrophia affinalata sp. nov.

Hipparionyx major sp. nov.

Chonetes baragwanathi sp. nov.

LAMELLIBRANCHIATA

Tancrediopsis raricostae (Chapman).

Cosmogoniophora sp.

Pterineid fragment.

GASTEROPODA

Loxonema australis (Chapman).

PHYLLOCARIDA

? Ceratiocarid telson.

DISTRIBUTION

Taking the specific determinations only, the distribution of the forms described is found to be as follows:

Faunule of Locality G 22.—*Acanthoclema flexuosa*, *Cariniferella alpha*, *C. beta*, *Eospirifer eastoni*, *Chonetes baragwanathi*.

Faunule of Locality G 23.—*Cariniferella alpha*, *C. beta*, *Protoleptostrophia affinalata*, *Hipparionyx major*, *Chonetes baragwanathi*, *Loxonema australis*.

Faunule of Locality G 24.—*Cariniferella alpha*, *Conchidium* cf. *polymitum*, *Protoleptostrophia affinalata*, *Tancrediopsis raricostae*.

From locality G 25 *Hipparionyx major* is the only specific determination, and from locality G 26 there were none.

AGE OF STRATA

Hill (1939, p. 220) stated that the beds at Sandy's Creek had previously been considered Upper Silurian, but in her opinion were Devonian; then, in a stratigraphical review in 1943 (table opposite p. 64), placed the Sandy's Creek beds on the boundary between Siegenian and Coblenzian, but indicating by arrows that

the age could be between basal Lower Devonian and basal Middle Devonian, as determined from the coral evidence.

In the present study, it is noted that the *Loxonema australis* from Sandy's Creek cannot be distinguished from the type specimen which came from the Lilydale limestone, nor *Tancrediopsis raricostae* from the type specimen collected from beds of Yeringian age at Killara. *Protoleptostrophia affinalata* cannot be specifically distinguished from specimens which occur in beds among the highest in the Lilydale sequence, viz., at Hull Rd., Mooroolbark. The *Eospirifer*, *Protoleptostrophia*, *Hipparionyx*, and *Chonetes* from Sandy's Creek are comparable with forms found in the Upper Yeringian shales and sandstones at Lilydale (*vide* Gill, 1945a), but are more advanced, and therefore probably slightly younger. Immediately above and slightly younger than the shales and sandstones at Lilydale is the Lilydale limestone, which is generally regarded as belonging to the upper end of the Lower Devonian, although Hill (1939, 1943) considers a Middle Devonian age possible. The Sandy's Creek beds containing the fossils described in this paper are probably comparable in age with the Lilydale limestone, but cannot be placed in the Middle Devonian because of the presence of the genera *Eospirifer* and *Hipparionyx*, which do not extend beyond the Lower Devonian. On present knowledge, therefore, the age of the Sandy's Creek beds referred to in this paper is considered to be the top of the Lower Devonian, i.e., Coblenzian.

A curious element in the fauna is *Cariniferella*, a genus of Upper Devonian age in North America and Europe. However, this genus has been erected comparatively recently, so that its range and relationships are not well known. It is herein recorded from Australia for the first time.

SYSTEMATIC DESCRIPTIONS

POLYZOA

Genus ACANTHOCLEMA Hall

Acanthoclema flexuosa Chapman

Acanthoclema flexuosa Chapman, Rec. Geol. Surv. Vic., Vol. IV, Pt. 2, 1920, p. 189. Pl. XXIV, Fig. 20; Pl. XXXII, Figs. 38-40.

A branching polyzoan from locality G 22 (specimens 27,207, 27,208 and 27,211) apparently belongs to Chapman's *Acanthoclema flexuosa*, described from the Gibbo River, N.E. Gippsland, and regarded as Yeringian in age. The holotype of this species is housed in the National Museum, and is Reg. No. 13,964.

BRACHIOPODA

Genus CARINIFERELLA Schuchert and Cooper

Cariniferella alpha sp. nov.

Pl. III, Figs. 1, 6, 7.

Type Material. *Holotype* consisting of the steinkern of a ventral valve, specimen 27,202 from locality G 22. *Paratype* consisting of the steinkern of a dorsal valve, specimen 27,219 from locality G 23. *Chonetes baragwanathi* sp. nov. occurs on the same face of the specimen.

Description of Holotype. Ventral valve sub-orbicular in outline, moderately convex. Hingeline straight, less than greatest width of shell; cardinal angles obtuse; rounded anterior border. Narrow low fold down midline. Length 2.1 cm., width 1.6 cm., the measurements being taken in one plane, i.e., not following the convexity of the shell surface. Interarea smooth, comparatively high (2.5 mm.), apsacline. Beak comparatively prominent, incurved.

Interior with deep delthyrial cavity; teeth strong. Well-defined dental plates, which in the holotype are continued as faint ridges which recurve round the anterior ends of the diductor scars. These ridges are not seen in all specimens. Diductor scars elongate, reaching a point 1 cm. from the umbo, i.e., nearly half way down the length of the valve; elevated adductor track, adjustor scars narrow, short, posterior to diductor impressions.

External ornament shown on margin of internal surface of valve, and is multicostellate, frequency of costellae being 25-30 per cm.

Description of Paratype. Dorsal valve of similar outline to ventral valve. Convex, but less so than ventral valve. Strongly developed carina or sinus down midline of shell; anterior commissure sulcate. Ornamentation multicostellate as shown round edge of steinkern; increase by bifurcation. Interarea smooth, anacline. Sockets deep, oblique; brachiophore plates widely divergent, high, merged with median callus ridge which fades into the carina down the midline. Cardinal process small, shaft narrow, serrated with almost vertical striae at the posterior end. The cardinalia are all close to the posterior margin of the shell.

Muscle field of dalmanellid type, ovate, divided mesially by the deep sulcus characteristic of the genus; almost surrounded laterally and posteriorly by ridges, which are crossed obliquely in two places on each side by faint furrows, i.e., ridges in the steinkern.

Comment. Specimen 27,213 from locality G 22 contains a partially decorticated dorsal valve of *C. alpha* which shows very clearly the punctate nature of the shell substance of this species; the nature of the median callus, brachiophores, and cardinal process can also be seen. The part of the external mould in view shows the presence of fine growth lines over the costellae, and two fine concentric rugosities. It shows also that there are intercalations among the costellae as well as bifurcations, although the latter are more common. The costellae are rounded in cross-section.

The genus *Cariniferella* is Upper Devonian in U.S.A. and Europe (Schuchert and Cooper 1932, Shimer and Shrock 1944), and has not been recorded from Australia before.

Cariniferella beta sp. nov.

Pl. III, Figs. 2-4, 9.

Type Material. *Holotype* consisting of the steinkern of a ventral valve, specimen 27,182 from locality G 22. *Paratype* consisting of the steinkern of a dorsal valve, specimen 27,210 from locality G 22. *Conchidium polymitum* occurs on the same face of the specimen.

Description of Holotype. General structure of shell similar to that of *C. alpha*, but—

(1) The proportions are noticeably different. The shell is transversely sub-elliptical, and measures 2.4 cm. wide and 1.4 cm. long, i.e., the proportions are the reverse of those found in *C. alpha*. *C. beta* is much wider than long, while *C. alpha* is much longer than wide.

(2) The muscle field assumes approximately the proportions of the general outline, and is more squat than in *C. alpha*. The muscle field is 8.5 mm. long down the midline, and 7 mm. wide across the middle of the field.

Description of Paratype. The general structure of the shell is very much like that in *C. alpha*, and the better development of the muscle field is probably just an expression of greater maturity in the paratype specimen of *C. beta*. However, the chief differences noted between the two species are:

(1) The differences in proportion noted in the ventral valve apply to the dorsal valve as well. The paratype dorsal valve is 2.2 cm. wide and 1.3 cm. long.

(2) The muscle field is more squat than in the compared species, measuring 6.5 mm. long (i.e., from the umbo) and 8.5 mm. wide.

(3) The median sulcus or carina is not so well developed as in *C. alpha*. This sulcus is deep in *C. alpha* in both young shells (e.g., on specimen 27,220) and old shells, but at no time in the life history is the sulcus deep in *C. beta*.

Comment. Study of the growth lines on these shells shows that the sub-orbicular outline of *C. alpha* and the sub-elliptical outline of *C. beta* are approximately the same throughout life, i.e., their outlines do not change in proportions during growth. The two species are readily distinguished by their outlines.

Genus CONCHIDIUM Hisinger, 1799

Conchidium polymitum sp. nov.

Pl. II, Fig. 7; Pl. II, Figs. 9, 12, 18.

Type Material. *Holotype* consisting of steinkern of ventral valve, specimen 27,181 from locality G 22.

Etymology. The trivial name is derived from the Greek word *polymitos* (= with many threads). It refers to the multistriate ornamentation of this species.

Description of Holotype. Ventral valve very convex. Umbo high but not overhanging that of the dorsal valve. Shell thick; ornamentation of very numerous striae. Part of the original calcic material of the shell is preserved and shows the shell substance to be impunctate.

Interior with strong spondylium supported by a median septum about 1 cm. long. Measured posteriorly the spondylium is 6.5 mm. wide and 8 mm. high on the outside measurement, and 5.5 mm. wide and 6.5 mm. high on the inside measurement. The septum is high; it is thick where it joins the spondylium on the floor of the shell, then gradually thins both dorsally and anteriorly. A fine furrow continues the line of the septum for some distance; this is flanked on one side by a fine ridge which may be the result of crushing. As with the other fossils of this fauna, the holotype has suffered shearing. Genital markings are very distinct in the umbonal area of the valve.

Comment. In the collection from Sandy's Creek there are two dorsal valves of *Conchidium* (specimens 27,205 and 27,228), but these vary from one another, and at present there is no way of telling whether one or neither of these is the dorsal valve of *C. polymitum*. However, in both specimens the septal plates are long (half the length of the valve or more) and slightly divergent.

From the series of specimens present, it is clear that *C. polymitum* was biconvex, subtriangular, and rectimarginate; also the

surface costellae had a frequency of about 24 per cm. However, the ornamentation was finer at the umbo (specimen 27,195B). The beaks of some specimens are more recurved than others, but none are as rostrate as the genotype.

The nearest relatives of *C. polymitum* are found in beds of similar facies and age at Killara and Lilydale, but these forms have not yet been described. Somewhat similar shells have been described by Shirley (1938, pp. 474-475) from the Baton River Beds of Lower Devonian age in New Zealand, but the coarse ornamentation on Shirley's specimens is very different from that on *C. polymitum*.

Genus EOSPIRIFER Schuchert, 1913

Eospirifer eastoni sp. nov.

Pl. III, Figs. 20, 21, 23.

Type Material. *Holotype* consisting of the steinkern of a dorsal valve on specimen 27,180, and part of the external mould of the same shell on specimen 27,183, the two specimens being counterparts. Both are from locality G 22, and *Chonetes baragwanathi* occurs on the same slab.

Description of Holotype. Valve convex, non-plicate, large, being about 5.5 cm. wide and the same long, the measurements being taken in one plane, i.e., not following the contours of the shell. When the profiles are followed, the width is about 7.8 cm. and the length 8.8 cm. Precise measurements are not possible as there is slight lateral crushing and all the margin is not preserved. Fold down middle of shell rises anterior to the umbo, rapidly gaining height and then gradually widening towards the anterior margin. The fold is about 7 mm. wide in the middle of the shell, and about 1 cm. wide at the anterior end. The fold varies from 4 to 5 mm. high. A narrow and low median fold is superimposed on the main fold from where the latter commences to a point more than half way down the midline of the shell.

Palintrope well developed; interarea covered with fine transverse striae, and 2.3 to 3 mm. high. Shell considerably thickened about the umbo; beak small. Hingeplate strong, divided, with laterally elongate sockets in which to accommodate the teeth of the ventral valve. Hingeplate supported by strong crural bases, which are in the form of lamellae, slightly divergent, which reach a point about 8 mm. from the umbo. They lose height rapidly just in front of the anterior edge of the hingeplate, but rise a little and thicken before terminating. Between them is a broad low ridge (a depression in the steinkern).

Ornamentation of fine costellae shows faintly on the steinkern, being clearer at the anterior end of the shell. The external mould shows the ornamentation to consist of fine costellae or striae, rounded in cross-section, which average 34 per cm., variation occurring according to the frequency of new intercalations. As increase is by intercalation, the new fine ribs alongside the full-sized ones sometimes give an appearance of pairing or alternation of costellar size. Fine growth lines cross the costellae, with a frequency of the order of 17 per mm. In places there are stronger growth lines, generally discontinuous. In the piece of external mould preserved, there are also a couple of growth lines so strong and continuous as to form fine ridges which interrupt the ornament.

Comment. The thickened shell and heavy growth lines are considered to be evidence of phylogerontism. *Eospirifer* ranges from Middle Silurian to Lower Devonian. Other specimens of *Eospirifer* have been figured from Victorian strata (Gill, 1942), and other undescribed forms are held, but the new species is nearest that figured in the 1942 paper on Plate VI, Fig. 8 (Nat. Mus. Vic., reg. no. 14,105), from Lilydale. Both have the superimposed secondary folds which are well known also in *E. secans* (Barrande) which Shirley (1938) has figured from the Baton River Beds of New Zealand. However, although alike, they differ in the structure of the cardinalia, and the Sandy's Creek fossil is notably bigger. The two forms are closely related but not identical.

The species is named after Mr. J. G. Easton, who collected the Sandy's Creek fossils.

Genus SPIRIFER Sowerby, 1814

Subgenus *Quadrifarius* Fuchs, 1923

Spirifer (?*Quadrifarius*) sp.

From locality G 22 on Sandy's Creek, there is preserved the steinkern of a spiriferid (specimen 27,195B). It is a ventral valve with a well-defined non-costate sinus on each side of which there are ten costae. The shell is broader than long, and the beak well-defined. The valve is 2.5 cm. wide and 1.8 cm. long, these measurements being taken in one plane. Dental plates 7-8 mm. long and about half a millimetre wide, which follow down the outer flanks of the costae on each side of the central sinus of the shell. There is also a weakly-defined median septum about 12 mm. long, i.e., about two-thirds the length of the shell. No external mould was among the fossils received, and thus it was impossible

to determine the nature of the external ornament, which is important in this case. For this reason the fossil is referred with some reserve to *Quadrifarius*, but it has the long ventral median septum and dental plates found in that subgenus (Fuchs 1923, Asselbergh 1930, 1931, Dahmer 1942). The long median septum and dental plates are seen also in smaller ventral steinkerns on specimens 27,216 (from G 23) and 27,232 (from G 25).

Genus PROTOLEPTOSTROPHIA Caster, 1939

Protoleptostrophia affinalata sp. nov.

Pl. II, Fig. 6; Pl. III, Figs. 19, 22.

Type Material. *Holotype* consisting of the steinkern of a ventral valve, specimen 27,214. There are more than twenty shells of this species on the slab or rock containing the holotype, along with a dorsal valve of *Chonetes baragwanathi*. The holotype is marked with an "A" on the specimen. *Paratype* consisting of a steinkern of a dorsal valve on the same slab of rock as the holotype. The paratype is marked with a "B" on the specimen.

Description of Holotype. Ventral valve slightly convex, subsemicircular. Width as preserved 2.7 cm., probably 3 cm. when complete; length 2 cm. Shell has a few weakly-developed, discontinuous, concentric wrinkles. Hingeline greatest width of shell; cardinal angles alate. Interarea makes an angle of the order of 120° (measured with the eye only) with the plane of the shell. Teeth file occupies only about one-quarter of the height of the area, which is about 1 mm. Teeth vertical (i.e., at right angles to the hingeline), fine, and even, there being approximately 3 per mm.

Muscle field well defined by dental ridges which form an angle of about 40° (though in other specimens it ranges as high as 70°); about 12 mm. long, i.e., more than half the length of the shell. At the posterior end, the muscle field is very narrow, then spreads out anteriorly. At the fine posterior apices of the diductor scars, on each side of the median septum, there are pronounced knobs on the steinkern which represent cavities on the original shell. The muscle scars are striate, and on each side of the median septum the diductors are divided by ridges into three more or less equal areas. The median septum is broad and low. At the posterior end the septum is characterized by a superimposed median furrow (ridge in steinkern) about 3 mm. long.

Outside the muscle field, the whole inner surface of the shell is very finely and closely papillose, the papillae extending right to

the margin of the shell, so that the costellae of the external surface are not shown as is so often the case with strophomenids. The papillae cover much of the median septum between the muscle scars, and also run up the ridges effecting the tripartite division of the muscle areas on each side of the septum.

Description of Paratype. Dorsal valve more or less flat with holocrenulate hingeline; there is no interarea apart from the teeth file. Small quadrifid sessile cardinal process, scarcely if at all extending beyond the hingeline. The two central prongs of the process are elongate, being about 1.5 mm. long and 0.5 mm. wide. They are but slightly splayed apart. On each side of these larger prongs, almost at the hingeline, are much smaller ones. Crural bases obsolete. Adductor scars small, posteriorly situated, the rims forming a pair of inverted U-shapes. Stronger papillae occur on each side of these scars than occur on the rest of the inner surface of the valve.

Comment. Other specimens on the same slab as the types indicate that the ornamentation of the external surface is costellate. The new species varies in proportions, but it is difficult to make satisfactory measurements owing to the crushing which the matrix has suffered. There are variations also in the length and width of the ventral median septum, although the specimens available hint that there may be two distinct varieties. More material is needed to determine this with certainty. The extension of the papillae to the edge of the inner surface of the ventral valve indicates that secondary deposition occurred over the whole of the interior of the valve, a condition which contrasts with that usually observed in strophomenids.

The large muscle field with its strongly developed ridges in the ventral valve is a mark of an advanced form in a genetic sequence, and may be compared with similar structures in *Hipparionyx*. The early protoleptostrophids show no division of the ventral muscle into bundles (e.g., *P. plateia* from Tasmania—Gill, 1948). Then follow forms in which a tripartite division is present, as in the new species described above. Finally, there is the group covered by the genus *Leptostrophia* in which a further division has taken place, giving six muscle bundles. Since *Proleptostrophia* is found in both Lower and Middle Devonian, while *Leptostrophia*, although a specialized form, existed only in the Lower Devonian, it is to be inferred that *Leptostrophia* was an offshoot from the main line of development. It appears to have ended in a cul-de-sac, while the less specialized *Proleptostrophia* gave rise to other forms.

Generic Position. This form is tentatively referred to *Proleptostrophia* (Caster, 1939), which has been defined in brief by Cooper (in Shimer and Shrock, 1944, p. 341) as "Smaller than *Leptostrophia* with nearly flat dorsal valve; ventral musculature like *Leptostrophia*; dorsal interior with small bilobed cardinal process and small posteriorly located adductor field." *P. affinalata* agrees with this diagnosis except for the two minute knobs outside the main prongs of the cardinal process, making it into a quadrifid one. However, *P. affinalata* closely approaches *Leptostrophia*, and without a bigger range of specimens one cannot be sure that fully mature forms are present.

The holotype of the new species possesses a few weakly-developed discontinuous wrinkles, but these are not the "strong concentric wrinkles as in *Leptaena*" to which Caster refers as distinguishing *Rhytistrophia*. There seems to be a gradation from shells without wrinkles into the strongly wrinkled ones accommodated in *Rhytistrophia*.

Affinities. The trivial name of the new species is intended to indicate its affinity with *P. alata* (Chapman, 1903) from north of Lilydale (for precise locality see Gill, 1940), which is Upper Yeringian. The two species have a similar crenulation, standing in contrast with another group of protoleptostrophids which has the whole height of the ventral interarea occupied by the teeth file as in the genotype of *Leptostrophia*. The two species also have similar alate cardinal angles, and both possess a quadrilobate cardinal process. However, *P. affinalata* differs from *P. alata* chiefly in the following points:

(1) The ventral muscle field of the new species is much more developed than in the compared species. *P. affinalata* has a large excavated muscle field with a long median septum, strong dental ridges, and ridges dividing the diductor muscles into bundles. *P. alata* has a smaller, unexcavated muscle field with but moderate dental ridges, and the diductor muscles not divided into bundles by ridges.

(2) The interior of the ventral valve is much more strongly papillose in *P. affinalata* than in *P. alata*, and the latter is characterized by a row of larger papillae ranged along the dental ridges. The second feature is seen in a number of protoleptostrophids including *P. plateia*, and undescribed forms from Killara and Heathcote districts in Victoria. No such row of papillae occurs in *P. affinalata*.

Distribution. Brachiopods not specifically separable from *P. affinalata* have been collected from Hull Road, Mooroolbark.

These specimens have the same long and well-defined ventral muscle field, although not quite so prominent as in *P. affinalata*. The ridges dividing the diductors into three bundles are present, but again not quite so prominently. Also, the whole interior of the valve is covered with fine papillae, but this secondary deposition is not sufficiently thick to completely mask the external ornament as is the case with the Sandy's Creek fossils. In short, the same structures are present in the specimens from the two localities, but their development is less pronounced in the Mooroolbark form. One is presented with the problem as to whether these differences are genotypic or phenotypic, due to inherent constitution or merely to facies effects or differences in degree of maturity. An attempt was made to solve this by studying the young forms of *P. affinalata* preserved on the same slab as the holotype. It was noted that in specimens half the size of the holotype that the same strong papillosity is present and extends right to the edge of the shell. It is thus clear that the extent of the internal ornament is not affected by degree of maturity. The same applies to the general definition of the muscle field. However, the median septum and ridges dividing the ventral diductors into bundles are very indistinct in the young specimens; these therefore are features that vary with degree of maturity. As there are no major facies differences between the Sandy's Creek beds and the Mooroolbark ones in which the fossils under discussion were found, it may be inferred that the difference in degree of internal ornament is a genotypic and not a phenotypic one. The most developed of the specimens from Mooroolbark is not nearly as advanced as the well-developed specimens from Sandy's Creek.

Variant Form. Specimen 27,229A from locality G 24 preserves a ventral valve of *Protopleptostrophia* which varies from *P. affinalata* in that the teeth occupy the whole of the ventral interarea, and not just the anterior part of it. This is the only specimen noted in the collection with this variation.

Genus HIPPARIONYX Vanuxem, 1842

Hipparionyx major sp. nov.

Pl. II, Figs. 1-3, 8.

Type Material. *Holotype* consisting of the steinkern of a ventral and a dorsal valve lying with hingelines together, flat open (specimens 27,177 and 27,179 glued together) and the external mould of same (specimens 27,178 and 27,201 glued together) from locality G 22. As the steinkern and external mould are impres-

sions of different parts of the same biological specimen, they are collectively regarded as the holotype. *Paratype* consisting of the steinkern of a dorsal valve (specimen 27,235) from locality G 25. It is to be noted that the paratype comes from a different locality from that of the holotype, but the two localities are close to one another both geographically and stratigraphically. A large part of a dorsal valve is also present in the material from G 22 (specimen 27,179).

Description of Holotype. Ventral valve outline subcircular. Valve flexed so as to be a little convex near the umbo and a little concave for most of the remainder of the shell. Hingeline shorter than greatest width. The broken margin precludes precise measurement, but the shell was 6.5-7 cm. long and 7.5-8 cm. wide. Ornamentation of costellae radially disposed except that those near the hingeline are bent back to meet it. On the umbonal half of the shell the ornament looks comparatively disperse, while in the marginal area it looks closely packed. On the umbonal half the costellae appear to alternate in size, while in the marginal half they appear to be of equal size. This general appearance is due, first of all, to the presence of primary costellae which alternate in the umbonal half of the shell with secondary costellae. The primary costellae can be traced right to the umbo, where the secondary costellae are so fine that they cannot be traced without doubt. The secondary costellae increase in size until they equal the primary ones. About a third of the way to the anterior margin, tertiary costellae are intercalated, and by half way down the shell they become a noticeable part of the ornament through increase in size.

Thus in the marginal half of the shell, primary, secondary and tertiary costellae, having reached equal size, impart a regular and fine appearance to the ornament. Towards the margin, further intercalations and some bifurecations cause the regularity of the ornament to be maintained. Concentric ornamentation is also present in the form of fine lines which in the centre were counted as 28 per cm., but on the sides of the shell are still finer, because the shell has to grow faster anteriorly than laterally in order to maintain its proportions. Yet a third type of ornamentation is present in the form of concentric rugae, or rather furrows. The most marked and continuous of these are where the more disperse ornament of the posterior end of the shell is replaced by the more regular ornament of the anterior end. The ornament of the dorsal valve is similar to that of the ventral valve. This description has been made from a plasticine impression of the external mould of the holotype.

Interarea 4.5 mm. high in the middle; forms a somewhat acute angle with the plane of the exterior shell surface. Teeth supported by strong dental plates which continue anteriorly into thick ridges which completely enclose the muscle field. The dental lamellae and ridges are not vertical, but rise from the floor of the shell inwards at an angle. Muscle field inverted heart-shape, 2.5 cm. long down the midline and with greatest width of 2.8 cm. Adductor impressions of oval outline, about 1 cm. long and 0.5 cm. wide, divided by a broad low median septum which becomes higher and sharper on the anterior side of the impressions. Adductor scars nearly smooth, and surrounded by diductor scars radially strongly furrowed, and with concentric fine lines and rugae. Anterior margin somewhat crenulate. The remainder of the interior of the ventral valve is marked with costellae (especially near the margin), with concentric ridges, and with very numerous fine papillae irregularly disposed. The papillae tend to be bluntly conical in shape, but a great number are irregular.

Interior of dorsal valve shows massive cardinalia. Strong blade-like septum 1.5 mm. high at the posterior end, but decreasing in height and width anteriorly. Septum reaches about 2.8 cm. from the hingeline. Large crural bases about 1.5 mm. wide, disposed more or less parallel with the hingeline.

Description of Paratype. The dorsal valve of the holotype, being *in situ*, is naturally partly hidden at the posterior end by the big umbo of the ventral valve. A paratype consisting of a steinkern of a dorsal valve is therefore presented in order to elucidate the umbonal structures. This steinkern shows a very large cardinal process with two large discrete prongs, each divided posteriorly into two small knobs or processes. The prongs are splayed apart (Pl. II, Fig. 2), are 3.5 mm. wide, and merged anteriorly into the median septum, which in this specimen is prominent for 2 cm. but continues less conspicuously to a point 3 cm. from the umbo. At the umbonal end, the septum is 1 mm. wide and 1.5 mm. high. The size of the cardinal process means it would project some distance into the umbonal cavity of the ventral valve, but the holotype steinkern shows that this was capacious. The crural bases are strong, 2 mm. wide, and stand parallel to the hingeline. The cardinal and brachial processes are fused into one massive plate. Palintrope obsolete.

Comment. Points of ecological interest are:

- (1) The presence of the two valves together in the holotype is evidence of comparatively quiet waters, an inference already made from the composition of the fauna as a whole.

- (2) The difference in ornamentation on the different parts of the mature shell means that the young forms have quite a different appearance from the older ones.
- (3) Specimens 27,231 and 27,216 show corals growing on *Hipparionyx* shells.
- (4) *Hipparionyx major* is the biggest Lower Devonian brachiopod known in Australasia, and perhaps in the world.
- (5) The costellae of the outer surface show clearly on the margin of the inner surface of the shell. Inside that margin is the papillate area. There are no papillae on the costellate margin of the inner surface. So apparently the shell was thickened by secondary deposition on the inside of the shell, and the papillae were part of the secondary growth.

Points of evolutionary and palaeogeographic interest are:

- (1) *Hipparionyx minor* and *H. proximus* form an evolutionary sequence in the Lower Devonian rocks of North America, the former being characteristic of the Chapman sandstone and the latter of the succeeding Oriskany sandstone. *H. proximus* is essentially a more developed *H. minor*. Such a sequence appears to be present in the Lower Devonian rocks of Victoria. Brachiopods from the Lilydale district have been referred to *H. minor* (Gill, 1942), and *H. major* sp. nov. is essentially a more developed *H. minor*, hence the trivial name. Although *H. major* is distinct from *H. proximus*, it is nevertheless comparable with it in degree of development and in size. In view of this evolutionary trend, it is likely that the beds containing *H. major* are a little younger than those containing *H. minor*. A similar conclusion is reached from the study of *Chonetes baragwanathi* sp. nov. and *Protoleptostrophia affinalata* sp. nov.
- (2) The massive character of the cardinalia, and the development of adventitious growth lines and rugae, may be interpreted as evidences of phylogerontism. Such evidences are present also in *Chonetes baragwanathi*. *Hipparionyx* is an offshore facies shell, but ponderous forms like *H. major* are not characteristic of that environment.
- (3) *Hipparionyx* is widespread in Victoria, occurring in many localities in the Lilydale area, at Mooroolbark (Hull Road),

at Kilsyth (for locality see Chapman, 1907), at Killara (Syme's Homestead—for locality see Gill, 1945b), and now in Gippsland. It appears to be strictly limited to beds of offshore facies. This is true also of New Zealand, where it occurs in the Lower Devonian beds of Bohemian (offshore) facies on the Baton River, but is not recorded from the contemporaneous beds of Rhenish (inshore) facies near Reefton.

Genus *CHONETES* Fischer, 1837

Chonetes baragwanathi sp. nov.

Pl. III, Figs. 10, 14, 16, 20, 23.

Type Material. *Holotype* consisting of the steinkern of a ventral valve on specimen 27,219 from locality G 23. *Paratype* consisting of the steinkern (specimen 27,214B) and an external mould (27,214A) of a dorsal valve from locality G 23.

Description of Holotype. Ventral valve sub-semicircular, strongly convex but also crushed a little anterior-posteriorly, thus shortening its natural length and exaggerating its natural convexity. Greatest width of shell 3 cm., greatest length (measured in one plane) 1.2 cm., and length following profile 2.1 cm. Shallow median fold as in *Chonetes robusta*. Hingeline straight and slightly less than greatest width of shell. Interarea smooth, narrow—about 0.5 mm. Along the cardinal margin are the stumps of strong spines set at right angles to the hingeline. There are indubitably three on each side of the umbo, and their positions suggest that there were five on each side. Beak inconspicuous. Thin and relatively high median septum extending to a point 3.5 mm. from the umbo, after which there is a continuation in the form of a very slight rise on the floor of the shell as far as 6 mm. from the umbo. The septum is merged with the palintrope posteriorly and ends abruptly anteriorly except for the linear incipient septum already mentioned. During cleaning, the steinkern broke away a little on the right side of the septum, but there is still clearly shown on the other side a small narrow platform, i.e., an excavation in the original shell, widening anteriorly and merging into the general floor of the shell where the main septum ends. Outside this platform on each side is a marked depression in the steinkern (raised portion in the original shell), outside of which again is a corresponding raised portion (depression in shell).

These structures are minute, occurring within 3 mm. radius of the umbo; they are interpreted as organs belonging to the muscular system.

When counted in the middle of the shell, there are 32 slightly sinuous costellae, some of which bifurcate so that they number 42 on the anterior margin. The costellae are moderately sharp in cross-section where well preserved, and each intercostellar space is approximately equal in width to the adjoining costella. The interior of the shell is closely and finely papillose, but the papillae tend to be limited to the intercostellar spaces of the steinkern (i.e., the inside surface of the costellae of the external surface), the possible significance of which has been discussed elsewhere (Gill, 1949a). The papillae are elongate and orientated to the direction of the costellae; they are generally less than 0.25 mm. long. Very fine growth lines appear on the holotype steinkern and have been noted on other steinkerns and external moulds (e.g., specimens 27,180 and 27,183, which are counterparts), so much so that they are regarded as characteristic of this species.

On specimen 27,200 is to be seen part of each of the two valves of this species *in situ*. The dorsal valve is strongly concave, and the space between the two valves small, as it is in *Chonetes robusta* (vide Chapman 1903, Pl. XII, Fig. 8).

Description of Paratype. Shell strongly concave, and of outline and ornament similar to those of the holotype ventral valve. From the small part of the hingeline preserved on the steinkern, it is inferred that the dorsal interarea was linear. On the interior, at the umbo, are two sub-rectangular plates or low flattened nodes between which (on the midline) there is a furrow shown by a raised platform on the steinkern. From the lower outer edges of the plates project fine plate-like septa 2-2.5 mm. long. Between the plates is a muscle area characterized by absence of costellae, due no doubt to secondary calcification. A median septum is present, about 6.5 mm. long, which is low and somewhat indistinct in the muscle field, but high and plate-like anterior to the field. The same long median septum and accessory septa are seen in specimen 27,183 from locality G 22. This is the steinkern of a dorsal valve, the external mould of which is seen on its counterpart, specimen 27,180 associated with *Eospirifer eastoni* sp. nov. (Pl. III, Figs. 20, 23).

Comment. *Chonetes baragwanathi* is closely related to *C. robusta* of the Upper Yeringian (Chapman 1903, Gill 1942, 1945a, 1949a, 1949b). It possesses similar general proportions and variations in proportions, similar convexity, similar small body space

between the valves, similar costellation, and similar short ventral median septum. On the other hand, the new species contrasts with *C. robusta* in—

(1) The presence of growth lines and papillae. Neither of these structures is seen in the holotype, which is re-figured in Pl. III, Fig. 17, nor have they been seen by the writer in any other specimen belonging to the species.

(2) The small structures on each side of the ventral median septum are quite different from those in *C. robusta*. The holotype of the latter does not preserve this area of the valve, and so there is figured herewith (Pl. III, Fig. 15) a specimen of *C. robusta* glued to the same plaque as the holotype by the author of the species as being a further typical example of the form; it is also a topotype.

(3) The costellae in *C. baragwanathi* occupy more space than those in *C. robusta*. The former is much bigger than the latter, but the two have approximately the same number of ribs.

(4) The holotype of *C. robusta* is larger than is usual for that species, and indeed I have seen none larger. But *C. baragwanathi* is half as big again as the holotype of *C. robusta*, and the other specimens present in the Sandy's Creek collection show that the holotype of the new species is a typical specimen.

(5) Of considerable interest and importance are the plates and long median septum in the interior of the dorsal valve. The umbonal plates are interpreted as crural bases because they occupy the position usual to those structures and could well fulfil their function. However, they are not as divergent as the crural bases usually are in *Chonetes*.

C. baragwanathi is the most advanced of the *C. robusta* group of species, viz., *C. robusta*, *C. killarensis*, *C. productoida*, and *Chonetes* sp. from Jerusalem Creek (Gill 1945c, p. 123).

Genus TANCREDIOPSIS Beushausen

Tancrediopsis raricostae (Chapman)

Pl. II, Fig. 4; Pl. III, Figs. 5, 8, 11.

Palaeoneilo raricostae Chapman 1908, Mem. Nat. Mus., Vic., No. 2, pp. 34-35, Pl. III, Fig. 50.

Material for Description. A single specimen (No. 27,229A) from locality G 24. It is a steinkern of a right valve, and a small piece of the external mould (No. 27,229B, now mounted in plaster of paris) was obtained when clearing the fossil; this shows the nature of the ornamentation.

Description. Length 2 cm., height 8 mm., and thickness (of single valve) 3 mm. Shell rostrate, the umbo being half way between the anterior and posterior ends of the valve. Shell convex, especially in the umbonal region, but somewhat depressed towards the outer margins. Anteriorly broad and well rounded; the margin meets the cardinal line at an angle of the order of 160° . Posteriorly the height of the shell is much reduced. There is a shallow but definite depression down the umbonal slope. At the posterior end of the shell, near the cardinal margin, is a sub-circular scar about 3 mm. in diameter. Cardinal line arcuate; dentition taxodont, teeth large. The beak is depressed so as to hide the central part of the cardinal line, but nine teeth can be counted on the anterior side of the umbo and ten on the posterior side (although the innermost one is small). The steinkern shows that the sockets are quadrate on the anterior side of the umbo, but on the posterior side they are more elongate and possess a median ridge (furrow in the steinkern).

As shown by the space between the steinkern and external mould, the shell was 0.5 mm. thick at the umbo. The fragment of external mould shows the ornament to consist of well-marked lamellae nearly a millimetre apart; the areas between the lamellae have numerous fine striae parallel with the lamellae.

Comment. The holotype specimen of this species (National Museum reg. no. 7,918) had only about one-eighth of an inch of the hingeline showing, the original figure being in the nature of a reconstruction to a certain extent. The steinkern has now been cleared and is re-figured (Pl. III, Fig. 11), but the hingeline characters are poorly preserved. The Sandy's Creek fossil is not considered to vary specifically from this type.

McLearn (1924, p. 100) referred Chapman's species to the genus *Tancrediopsis*.

Genus COSMOGONIOPHORA McLearn, 1918

Cosmogoniophora sp.

Part of a valve is preserved on specimen 27,226 from locality G 24. McLearn established the genus to include *Goniophora* species possessing radiating striae. *Cosmogoniophora* was noted to be very common in the Devonian, but in the Silurian confined to the Arisaig Stonehouse Formation. Shells with ornament similar to the one from Sandy's Creek occur at Hull Road, Mooroolbark.

Genus LOXONEMA Phillips, 1841

Loxonema australis (Chapman)

Pl. II, Fig. 5.

Loxonema sinuosa Sowerby, var. *australis* Chapman 1916, p. 96, Pl. V, Fig. 39.

Chapman's new variety was based on a fragment of a shell from Cave Hill, Lilydale, consisting of most of one whorl and a little of the one above it. For reasons set out below the variety is raised to species status.

Re-description of Holotype. This is National Museum reg. no. 12,851. The whorl profile is rounded, and the sutures moderately deep. The whorl is about 2 cm. in diameter and the part visible in the complete shell about 1 cm. high. The ornamentation is costellate, the costellae being of rounded cross-section, and the interspaces the width of a costella or less. There are eight to nine costellae per cm. The costellae begin at the upper suture at almost a right angle to the suture, then curve round so as to make an angle of about 50° with the lower suture. One small area of steinkern shows that the interior was smooth.

Comment on Holotype. It is very difficult to make out the "tendency to form a faint nodose shelf near the basal part of the whorl" on which Chapman based his variety. However, the form contrasts with *L. sinuosa* in that the ornament is much coarser, and the costellae follow a much straighter course. In *L. sinuosa* the costellae are sigmoid, but this term can scarcely apply to the form from Lilydale. In view of these marked differences, I suggest the variety be established as a species.

Description of Sandy's Creek Form. Specimen 27,217 from locality G 23 is a steinkern of the two lower whorls, above which appears the external mould of five further whorls, but the nucleus is missing. The steinkern of the lowest whorl is not quite complete, but the one above it is 1 cm. in diameter. The whorls decrease evenly in size, and the highest is 2 mm. in diameter. The whorl profile is rounded and the sutures moderately deep. The ornamentation is costellate, and the course of the costellae across the face of the whorl is as described for *L. australis*. The steinkern shows that the interior was smooth, except that the ornamentation shows faintly on part of the lowest whorl.

Comment on Sandy's Creek Form. The only difference I can see between the type of *L. australis* and the form just described is that the form is larger and the ornamentation proportionately coarser. As the whorls get bigger, the costellae become fewer per cm. of whorl face. On present knowledge it would appear that the

Sandy's Creek form belongs to *L. australis*. The holotype is rather an inadequate specimen, but better topotype material has not yet been found to enable a fuller description of the species.

In the National Museum collection (reg. no. 1569) there is a similar form of *Loxonema* from "Griffith's Kiln, 7 miles south of Mansfield," i.e., Loyola. The specimen was presented by Mr. E. O. Thiele. The Loyola locality is also a Yeringian one (Lower Devonian). The North American forms *L. hamiltoniae* Hall and *L. delphicola* Hall, both of Hamilton age, are of similar type to *L. australis*.

?*Ceratiocaris telson*

Pl. III, Fig. 13.

On specimen 27,226 from locality G 24 is a fossil of uncertain affinities. It may well be the telson of a large ceratiocaris. Its length is 8.8 cm. and its width 6.5 mm. at one end and 1.5 mm. at the other. The fossil is a smooth steinkern, not quite complete. The line down the length of the spine is a fracture such as would be expected with the crushing of a hollow structure of this shape. The flattening exaggerates the natural width at the wide end. The fossil appears to have been originally of oval cross-section, and in this it differs from any eurypterid spine I have seen. The broken wide end suggests a broken-off spine. However, the possibility of the fossil being a particularly large *Coleolus* type of shell, for instance, cannot be dismissed, but no sign of the ornamentation common with such forms is in evidence. Shells of the *Coleolus* type are common in Lower Devonian beds in Victoria, but are always comparatively small.

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DESCRIPTION OF PLATES

PLATE II

- Fig. 1. *Hipparionyx major* sp. nov. External mould of HOLOTYPE.
- Fig. 2. *Hipparionyx major* sp. nov. Steinkern of PARATYPE. The posterior margin has been partly inked in to assist recognition of structures.
- Fig. 3. *Hipparionyx major* sp. nov. Steinkern of HOLOTYPE dorsal valve.
- Fig. 4. *Tancrediopsis raricostae* (Chapman). Steinkern $\times 2$ to show hingeline features. HYPOTYPE.
- Fig. 5. *Loxonema australis* (Chapman), showing part of steinkern and part of external mould. HYPOTYPE.
- Fig. 6. *Protolaptostrophia affinalata* sp. nov. Posterior margin of HOLOTYPE steinkern enlarged to show hingeline features. $\times 2$.
- Fig. 7. *Conchidium polymitum* sp. nov. Part of steinkern of HOLOTYPE enlarged to show character of interior plates of ventral valve. $\times 2$.
- Fig. 8. *Hipparionyx major* sp. nov. Steinkern of HOLOTYPE photographed to show especially the ventral valve interior.

Note. Figures are natural size except 4-7, which are enlarged to twice natural size in order to show certain structures more clearly.

PLATE III

- Fig. 1. *Cariniferella alpha* sp. nov. HOLOTYPE steinkern, ventral valve.
- Fig. 2. *Cariniferella beta* sp. nov. External mould of ventral valve preserved on specimen 27,202. HOLOTYPE.
- Fig. 3. *Cariniferella beta* sp. nov. HOLOTYPE steinkern, ventral valve.
- Fig. 4. *Cariniferella beta* sp. nov. External mould of ventral valve preserved on specimen 27,182. HYPOTYPE.
- Fig. 5. *Tancrediopsis raricostae* (Chapman). Fragment of external mould of Sandy's Creek specimen. HYPOTYPE. $\times 2$.
- Fig. 6. *Cariniferella alpha* sp. nov. External mould of dorsal valve preserved on specimen 27,182. HYPOTYPE.
- Fig. 7. *Cariniferella alpha* sp. nov. PARATYPE steinkern of dorsal valve.
- Fig. 8. *Tancrediopsis raricostae* (Chapman). Specimen from Sandy's Creek. HYPOTYPE.
- Fig. 9. *Cariniferella beta* sp. nov. PARATYPE steinkern of dorsal valve. Beside it is a specimen of *Conchidium polymitum* sp. nov. to show the nature of the ornament (HYPOTYPE).
- Fig. 10. *Chonetes baragwanathi* sp. nov. PARATYPE steinkern of dorsal valve showing internal structures.
- Fig. 11. *Tancrediopsis raricostae* (Chapman). HOLOTYPE. The hingeline was cleared before this photograph was taken.
- Fig. 12. *Conchidium polymitum* sp. nov. HOLOTYPE steinkern.



Victorian Devonian Fossils.

- Fig. 13. Steinkern of ?ceratiocarid spine.
- Fig. 14. *Chonetes baragwanathi* sp. nov. HOLOTYPE steinkern showing umbonal features. The median septum looks thick due to a slight breaking away of the steinkern, but it is actually linear.
- Fig. 15. *Chonetes robusta* Chapman. HYPOTYPE figured to show umbonal structures.
- Fig. 16. *Chonetes baragwanathi* sp. nov. General view of obese ventral valve, the HOLOTYPE steinkern. See Fig. 14 for another view of the same shell.
- Fig. 17. *Chonetes robusta* Chapman. HOLOTYPE.
- Fig. 18. *Conchidium polymitum* sp. nov. General view of steinkern of ventral valve (HOLOTYPE). See Fig. 12 for umbonal view.
- Fig. 19. *Protoleptostrophia affinalata* sp. nov. Steinkern of dorsal valve (PARATYPE).
- Fig. 20. *Eospirifer eastoni* sp. nov. Steinkern of dorsal valve. HOLOTYPE. On the same slab are two valves of *Chonetes baragwanathi* sp. nov. (HYPOTYPES.)
- Fig. 21. *Eospirifer eastoni* sp. nov. Umbonal view of HOLOTYPE.
- Fig. 22. *Protoleptostrophia affinalata* sp. nov. The HOLOTYPE is the ventral valve steinkern nearest the figure number. Two young specimens are below it.
- Fig. 23. *Eospirifer eastoni* sp. nov. Piece of external mould of HOLOTYPE to show costellation. Also opposites of valves of *Chonetes baragwanathi* seen in Fig. 20.

Note. All figures are natural size except No. 5, which is $\times 2$ to show nature of surface ornamentation.

YERINGIAN (LOWER DEVONIAN) PLANT REMAINS
FROM LILYDALE, VICTORIA, WITH NOTES ON A
COLLECTION FROM A NEW LOCALITY IN THE
SILURO-DEVONIAN SEQUENCE

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Plates IV-VI, Fig. 1.

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The main object of the present paper is to give a description of plant remains from type localities in Yeringian beds at Lilydale, Victoria. The principal locality (Hull Road, Lilydale) was referred to in a previous paper (Cookson 1935, p. 146) and subsequently a list of the main types collected there was recorded (Cookson 1945). This collection now includes remains referable to or at least comparable with *Sporogonites*, *Zosterophyllum*, *Yarraria* and *Hedeia*. It will be supplemented by reference to specimens from two additional outcrops, one near Lilydale and the other at Killara, about $7\frac{1}{2}$ miles further east.

The occurrence of plants in this area is of special stratigraphical interest. For many years, the Yeringian series was believed to belong to the Silurian period, but the position assigned to it within that range of time varied according to the author (see Gill 1942, Table I). Chapman and Thomas (1935), when defining the Victorian Silurian succession, correlated the Yeringian with the Upper Ludlow of Britain. Beneath it they placed the Melbournian division (Lower Ludlow), whilst the basal series, the Keilorian or Lower Silurian, was correlated with the Llandoveryian of the British succession. Later Thomas (1937), in dealing with Silurian rocks of the Heathcote area, pointed out that detailed work was necessary to determine "how much of the Devonian is included in the Yeringian."

In 1938 Shirley noted that "the Yeringian contains at least one fauna similar to that of the Baton River series" (Lower Devonian of New Zealand). During the same year, in a discussion of the stromatoporoid fauna of the Yeringian limestone at Cave Hill, Lilydale, Ripper (1938) made the suggestion that this deposit "should probably be placed in the Devonian." Hill (1939), on the evidence of the rugose corals of the same limestone, concluded that its age is either Lower or Middle Devonian. Shirley's contention

regarding the Yeringian shales and sandstones has been supported by the work of Gill (1942) on fossils in the shaley beds of the type Yeringian area. In his conclusion Gill wrote: "The age of the shales and sandstones is shown to be Devonian. In part at least these beds can be correlated with the Baton River (Lower Devonian) beds of New Zealand described by Shirley. The fauna reveals definite affinities with the European and North American Lower Devonian faunas."

It seems clear, therefore, that the small Yeringian flora from the Lilydale district which will now be considered can be definitely regarded as Lower Devonian.

Most of the Yeringian plant remains were collected from a small cutting on Hull Road about 14 chains south of its junction with the main highway from Melbourne to Lilydale. The name that Gill (1940, p. 357) suggested should be used for this particular locality is "Hull Road, Lilydale." Here the plant fossils occur together with well preserved animal remains in soft pink or white shales which underlie and are conformable with the Yeringian limestone (Lower Devonian) of Cave Hill. The specimens are either casts or flattened incrustations in which the original tissues are represented by small flakes of carbon or a brownish mineral substance. Such preservation, while quite adequate for sound general comparisons, limits the possibility of specific identification. The remains from this deposit are cf. *Sporogonites*, *Zosterophyllum australium*, *Yarravia* cf. *oblonga* and *Hedeia* cf. *corymbosa*, and will be considered in that order.

1. cf. *Sporogonites*

Plate IV, Figs. 1 and 2.

Several specimens were found at Hull Road which compare closely with *Sporogonites* (Halle 1916). Each consists of a slender stalk and a terminal capsule-like body. The appearance of the latter suggests that it was a spore-containing structure, but no trace of spores has been preserved on the flattened incrustations.

The largest example, shown enlarged 10 diameters in Plate IV, Fig. 1, illustrates the general appearance of such specimens. The axis is unbranched, about 0.5 mm. wide, and broadens gradually into a club-shaped terminal capsule. This, including the widened part of the stalk, is 4 mm. long and 2 mm. broad, and narrows slightly towards the apex. A narrow peripheral zone represented by a solid cast of a brown mineral substance is marked off from the uniform central region of the capsule.

A second specimen and its counterpart are represented at a magnification of 10 diameters in Plate IV, Figs. 2 and 3. The

stalk is about 0.75 mm. wide, and approximately 6 mm. long. The capsule measures 3.6 mm. in length and 2 mm. in breadth, and is slightly tapered towards the rounded apex. The margin is not preserved in the solid as in the previous example, but a curved ridge which follows the outline of the capsule a short distance within the margin appears to mark off a central dome-shaped area from a peripheral zone. The central portion occupies an area within the capsule of 3 mm. by 1.75 mm. It is lighter in colour than the rest of the specimen because of the partial removal from it of the reddish mineral substance that has replaced the plant tissues. The significance of these two areas is not clear.

The remaining specimens, apart from providing a range in size, do not help in the more exact determination of the fossils. The capsule of the smallest specimen is 2.5 mm. long and 1.5 mm. broad.

These specimens must be considered in relation to two simple Lower Devonian plants. They are *Sporogonites* and *Cooksonia*. In both, slender leafless axes terminate in large sporangia. In *Sporogonites* the axes, as far as is known, were unbranched. This feature has been remarked upon by Halle (1936) and Lang (1937). In *Cooksonia*, on the other hand, dichotomous branching of the axes which bear the sporangia is of usual occurrence and frequently takes place only a short distance behind the sporangia. For this reason and in spite of a rather close similarity as regards size and shape of their sporangia to those of *Cooksonia* sp. from Llanover, Wales (Croft and Lang 1942), it seems inadvisable to identify the present specimens with this genus.

Comparison with *Sporogonites* appears closer. Two species are known, *S. exuberans* from Norway, Belgium and Wales, and *S. chapmani* from Victoria. The capsules of the Lilydale specimens are distinctly smaller than typical examples of either species. A considerable variation in size, however, has been noticed in *S. exuberans forma belgica* by both Lang (1937) and Stockmans (1940), and a small form of *S. chapmani* has been described as *forma minor*. The grooving of the basal region of the sporogonium, evident in both *S. exuberans* and *S. chapmani*, is also not a constant feature and its absence from the Hull Road fossils acquires less significance when the unsatisfactory nature of the preservation in this soft shaley deposit is taken into account. To the nature of fossilization may perhaps also be attributed the apparent absence from the Lilydale specimens of the clearly defined sterile basal zone which is such an interesting morphological feature of the capsules of *Sporogonites*. In view of these considerations a modification of the earlier record of these speci-

mens (Cookson 1945) as *S. chapmani* is desirable. For the present it seems preferable that they should be considered as remains of a simple plant of the same general type as *Sporogonites* but not necessarily identical with that form.

The Australian species *S. chapmani* is only known from two localities in the Centennial beds at Walhalla.

2. *Zosterophyllum australianum*

Plate IV, Figs. 7-8.

A few specimens have been recognized as detached sporangia of *Zosterophyllum australianum*. In size and form these agree with sporangia of this plant from the Centennial beds and from Mount Pleasant. The most clearly defined specimen is shown magnified 4 diameters in Plate I, Fig. 7. The sporangium, which has a width of approximately 5 mm., is tangentially expanded, and the stalk and marginal rim are clearly defined. In this example the sporangium is flattened considerably so that the line of dehiscence is directed towards the observer and a portion of the other side of the sporangium is visible.

Another sporangium (Plate IV, Fig. 8) viewed laterally shows the line of dehiscence near the summit of the sporangium.

3. *Yarravia* cf. *oblonga*

Plate IV, Figs. 4-6.

A few specimens demonstrate the presence in the deposit at Hull Road of *Yarravia*, a synangial fructification originally described from the Monograptus beds of the Yarra Track (Lang and Cookson 1935). The specimens are flattened incrustations or imperfectly preserved casts. In size and general form they agree essentially with one of the specimens compared with *Yarravia* from Mount Pleasant (Cookson 1935, Fig. 34). No evidence of spores has been seen.

The example shown at a magnification of 4 diameters in Plate IV, Fig. 4, is the best of a small number of specimens collected. Its counterpart is represented in Plate IV, Fig. 5. The stem is approximately 1 mm. wide and broadens towards the terminal fructification which is 3 mm. wide and about 8 mm. long. Three linear sporangia are shown on the exposed plane and two of these end in tips that are free from one another. The tip of the third sporangium on the left-hand side is partly obscured by the matrix, but, as far as can be ascertained, this sporangium is identical with the other two. For a short distance behind the tips, the brown mineral that has replaced the plant tissues is continuous between

the sporangia; in other places it appears to have been broken away during the splitting of the stone. It seems probable that here, as in the specimens from the *Monograptus* beds, the elongated sporangia were completely coherent in the fructification, only their tips having been free.

The appearance of the specimen illustrated in Plate IV, Fig. 6, strongly supports this conclusion. The fructification in this case is broader than that of the preceding example and has convex rather than straight sides. It is 6 mm. broad and 8 mm. long. Three sporangia of equal dimensions can be seen in the exposed view of the fructification. Two of these terminate in pointed tips identical with the free apices of the previous specimen, the apex of the third being hidden by the matrix.

The specimens from Lilydale agree, both in size and form, more closely with *Yarravia oblonga* than with *Y. subsphaerica*. There are deviations from this type which may possibly be accounted for by the different mode of preservation in the two cases. In the present state of our knowledge, however, *Yarravia* cf. *oblonga* seems the best name for the Hull Road specimens.

4. *Hedeia corymbosa*

Plate IV, Figs. 9-11; Plate V, Figs. 12-17.

The name *Hedeia* was originally applied to some fertile branch-systems, believed to have been radially constructed, from Mount Pleasant, Alexandra (Cookson 1935). These were characterized by the successive equal or unequal dichotomy of several daughter axes which, themselves, arose terminally from the parent axis, and by the termination of the ultimate members of the branch-system in large elongate-oval sporangia. The tips of the sporangia all reached the same level, giving the fructification a corymbose appearance. Although some differences in the details of the branching were evident in the various examples, all were kept in the one species, *H. corymbosa*. Nothing is known of the plant to which such fructifications belonged.

Several small branch-systems from Hull Road exhibit the peculiar type of branching associated with *Hedeia*, but in none of them can the ultimate terminations be clearly recognized as sporangia. While uncertainty remains regarding such an important character, specific identification with *H. corymbosa* cannot be established.

One of the best specimens of this kind, which as regards its mode of branching can be closely compared with one of the examples of *H. corymbosa* from Mount Pleasant (*loc. cit.*, Figs. 25, 26), is

shown in Plate IV, Fig. 9. In it three secondary axes which arose terminally from the parent axis are exposed. Of these the one on the left-hand side appears to have been unbranched; the other two show two successive dichotomies at identical levels and their ultimate terminations attain to the same level above.

The corymbose branch-system shown enlarged 4 diameters in Plate 5, Fig. 13, has a special interest, since it clearly demonstrates a radial construction. It is preserved as a solid cast in which minute carbonaceous fragments distinguish the branches themselves from the light grey matrix which during fossilization filled the spaces between them. By an oblique splitting of the rock this specimen was exposed in such a way that, in addition to the usual lateral view, its distal end could be observed from above. At the same time the counterpart of the distal portion (Plate 5, Fig. 14) became available for examination.

When viewed laterally (Plate V, Figs. 12, 13) the origin at one level from the main axis of four secondary branches is clearly shown. Of these branches the one on the extreme left (text fig. 1, a¹) is almost completely covered by the stone, but the three small casts (a³) which project distally beyond the matrix are in a position which suggests that they represent the terminations of its daughter-axes. The two centrally placed secondary branches (b¹, c¹) each show two successive dichotomies at similar levels, but on account of the fracture which resulted in the exposure of the distal portion of the branch-system only short lengths of their terminations (b³, c³) can be traced in the specimen. These appear also in the counterpart but without providing the evidence required to establish their identity as sporangia. The ramifications of the fourth secondary branch (d¹) on the right-hand side of the specimen are obscure and need no further consideration.

When the distal region of the fossil is examined the conical tips of three flattened casts (e³) can be seen lying on the rock behind the specimen. They have a brown colour and, since small carbonaceous fragments have been retained on their surfaces, clearly belong to the branch-system. Their position at the back of the specimen suggests that they are the ultimate terminations of a fifth secondary branch that lies behind the matrix now occupying the centre of the fossil. Their position is indicated in the counterpart by small compressed cavities (e³).

Although the preservation of this interesting fossil precludes detailed interpretation and specific identification, certain conclusions can be drawn from its study. By it the presence of *Hedeia* in Hull Road is confirmed and the radial symmetry of such branch-systems fully established. As far as the preservation

of this specimen will allow us to judge, five daughter-axes, at least, must have been terminally arranged around a central space and further subdivisions of these axes occurred by successive dichotomies at identical levels in one plane only. The corymbose nature of this branch system is particularly obvious and, in the absence of positive evidence to the contrary, strengthens the possibility that the fossil represents a fructification closely similar to that of *H. corymbosa*.

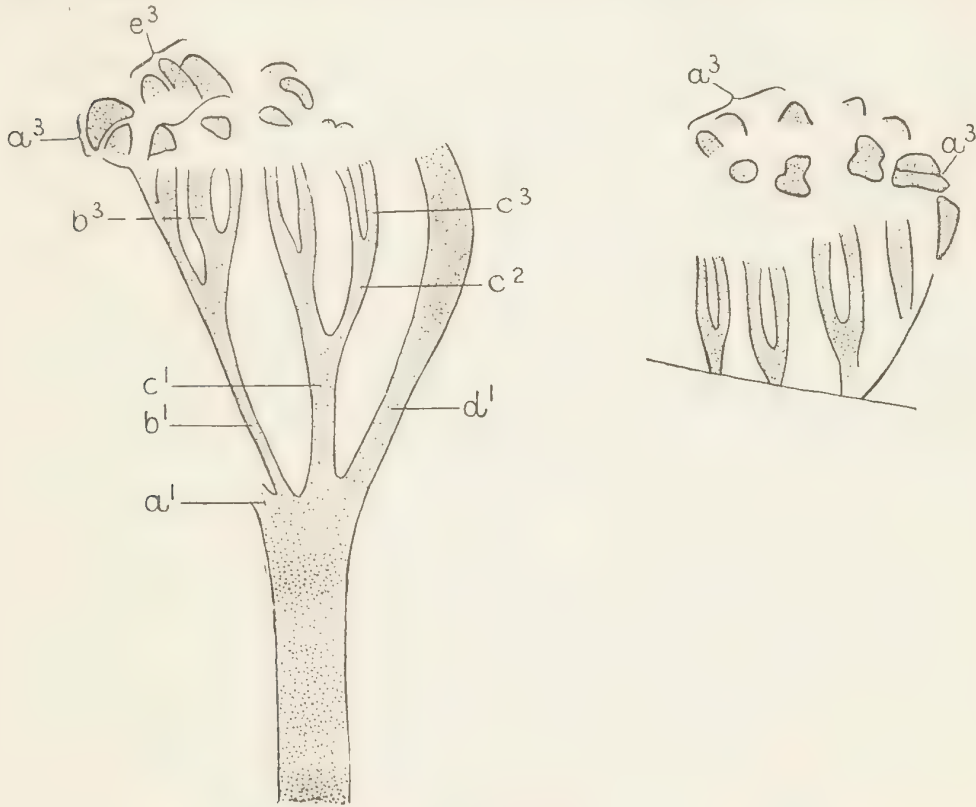


FIG. 1

Hedeia cf. *corymbosa*. Tracings made from photographs of specimen C. 102 and the counterpart of its distal region, $\times 5$.

Recently, branch-systems of the *Hedeia* type were discovered by Mr. E. D. Gill, Palaeontologist of the National Museum, Victoria, at a Yeringian locality situated at the right-angled turn in Albert Hill Road, Lilydale. I am indebted to Mr. Gill for permission to record this occurrence.

As was the case with the Hull Road material, both the nature and form of the ultimate ramifications of the individual branch-systems from this locality is uncertain and again the only suitable

designation for them is *Hedeia* cf. *corymbosa*. The corroborative evidence regarding the radial construction of such branch-systems provided by one of the specimens (Nat. Mus. Vict., Nos. 14661, 14662) is, however, of some interest. In this instance the rock split in such a way that a practically complete cross-section of the distal region of a partially carbonized branch-system was exposed. This portion of the specimen is illustrated at a magnification of three diameters in Plate IV, Fig. 11. In it can be counted some fourteen tube-like cavities, more or less completely filled with cores of matrix, the appearance and arrangement of which suggest a derivation from a radially arranged series of terminal branches. A portion of the proximal region of the same branch-system is illustrated in Plate IV, Fig. 10, where the main stem shows the origin of two short branches which in turn appear to undergo further subdivision at identical levels.

A second specimen from the same locality is shown enlarged two diameters in Plate V, Fig. 15. It is an impression of a rather large branch system in which three short secondary branches arise from the main axis (not preserved) at one level. Each of these branches shows three successive dichotomies at one level. The final ramifications can be traced for some distance in the right-hand branch without sign of sporangial enlargements.

A single specimen collected by Mr. Gill at a third Yeringian locality—Syme's Homestead, Killara—is shown in Plate V, Fig. 17.

On the whole, the branch-systems from the Lilydale outcrops are smaller and more compact and "bud"-like than those from Mount Pleasant. They indicate that this type must have been relatively abundant in Lower Devonian times and raise the question as to whether this peculiar type of branching may have been associated with vegetative as well as fertile axes.

5. Smooth branched axes. *Incertae Sedis*

Plate V, Figs. 18-20.

As is frequently the case in early Palaeozoic rocks, the most numerous plant-fossils at the Hull Road outcrop are pieces of smooth, rigid stems. These are from 1 to 8 mm. in width and some are branched by what appears to have been equal or slightly unequal dichotomy.

It is possible that specimens similar to those in Plate V, Figs. 18, 19 and 20, are portions of plants which have been identified from these beds by their fructifications, but as disconnected fragments can only be recorded as *Incertae Sedis*.

DISCUSSION

The various types of plants known from early Palaeozoic rocks of Victoria have been described and figured in three papers. Those from a number of exposures in the *Monograptus* beds (Lower Ludlow) include *Baragwanathia* and *Yarravia* (Lang and Cookson 1935). The chief types from the Centennial beds of the Walhalla series are *Sporogonites* and *Zosterophyllum*. When these were first described (Lang and Cookson 1930) their age was believed to be Upper Silurian or possibly Lower Devonian (Skeats 1928), but now it is definitely regarded as Lower Devonian (Thomas 1937, Gill 1942). The collection of plants from Mount Pleasant, Alexandra (Cookson 1935) is not as yet definitely dated by animal remains. The interest is that it combines in one flora types known from the Lower Ludlow horizon (*Yarravia*) with others known from the Lower Devonian horizon of the Centennial beds (*Zosterophyllum* and *Pachytheca*).

The flora from Lilydale described in the present paper also combines plants from the lower horizon (*Yarravia*) with others from the upper horizon (*Sporogonites*, *Zosterophyllum*) but has the advantage of being stratigraphically dated. It is this rather than the descriptive details of the plant remains themselves that constitutes the importance of the Lilydale flora as at present known, for in the case of each type better preserved examples are known from other localities.

The small Lilydale flora taken along with the Mount Pleasant assemblage provides evidence of the essential similarity of the vegetation of Victoria from the Lower Ludlow to the Lower Devonian. The composition of this Siluro-Devonian flora in Australia of definite land plants with a vascular system and a considerable morphological complexity is a fully established piece of knowledge concerning early plants. The grade of organization of the plants from the *Monograptus* beds onwards is at least as high as that first met with in the Lower Devonian of the Northern Hemisphere. It is interesting that there are detailed points of agreement in the occurrence of the same generic types (*Zosterophyllum*, *Sporogonites*, *Pachytheca*) or of closely agreeing types (*Baragwanathia* in the Australian flora representing *Drepanophycus*).

In the Northern Hemisphere the representation of early vascular land plants is best and clearest in the upper beds of the Lower Devonian or Lower Old Red Sandstone where *Psilophyton*, *Drepanophycus*, and *Zosterophyllum* are met with, together with other vascular plants and with more anomalous types such as *Prototaxites*, *Nematothallus*, and *Pachytheca*. At lower horizons

of the freshwater Lower Devonian a somewhat simpler assemblage of plants is met with and this is even more marked in the Downtonian where brackish water held (Lang 1937). The simplification of type by the absence of the more definite land plants is probably an ecological rather than an evolutionary feature. There are, indeed, indications that plants of the Lower Devonian and Downtonian will be traced back to the Silurian of the northern area. At present, however, there is no demonstration of a Siluro-Devonian land flora in the Northern Hemisphere, though it may have existed, as is afforded by the Lower Devonian of Lilydale and Walhalla and the Lower Ludlow of the *Monograptus* beds of Victoria.

FOSSIL PLANTS FROM SANDSTONE BEDS ON THE WARBURTON-
WOOD'S POINT ROAD NEAR YANKEE JIM CREEK

If an adequate knowledge of early vascular plants is to be obtained, a large number of outcrops, where plant-remains are preserved, must be carefully worked. The discovery by Dr. W. J. Harris and Dr. D. E. Thomas of another plant-containing locality in the Victorian Siluro-Devonian is, therefore, of interest. These plant beds are situated in a roadside quarry on the Warburton-Wood's Point Road about 22 miles from Warburton and adjacent to Yankee Jim Creek. In the absence of animal fossils, they cannot be palaeontologically dated. Dr. Thomas, however, has kindly expressed to me his personal opinion that they are stratigraphically higher than the *Monograptus* beds and are probably Lower Devonian. The plant-fragments are preserved as flattened incrustations in a dark grey sandstone, the plant tissues being represented by a brown mineral substance. The majority are small pieces of stems, but a few more connected specimens are sufficiently distinctive for classification. The identifiable types include *Pachytheca* and *Zosterophyllum*.

1. *Pachytheca* sp.

Plate VI, Fig. 22.

The alga *Pachytheca* was first recognized in Victoria from two specimens obtained at Mount Pleasant, Alexandra. Their identification enabled some more doubtful objects, from the Centennial Beds, to be associated with them as additional though more imperfectly preserved examples of the same organism.

A single carbonized specimen from the beds near Yankee Jim Creek can also be identified as *Pachytheca* sp. It is shown magnified three diameters in Plate VI, Fig. 22. The specimen is split

across so that the characteristic differentiation into medullary and cortical regions is revealed. The example is a slightly compressed spherical body, 6.5 mm. in diameter, the medulla being about 4 mm. in diameter and the cortex about 2 mm. broad. The fine radial striations which were clearly visible in the better preserved specimen from Mount Pleasant cannot be distinguished in this example, but the way in which the carbonaceous material has split and broken away is quite consistent with a radial construction.

Pachytheca is a rare fossil in the Southern Hemisphere. It has been found only in small numbers in the Mount Pleasant and Centennial beds; its occurrence at a third, widely separated locality is therefore of interest.

2. *Zosterophyllum australianum*

Plate VI, Fig. 21.

Z. australianum is represented in this deposit by fertile spikes and detached sporangia.

The unusually large and almost complete spike shown of natural size in Plate VI, Fig. 21, was found by a member of Dr. Harris's party and presented to the Geological Museum, Melbourne. I am indebted to the Chief Geologist of the Mines Department, Dr. D. E. Thomas, for permission to examine and figure this very fine specimen. It consists of a smooth axis, 3 mm. broad and 2 cm. long, and a terminal spike of a uniform width of 8 mm. and a length of 4.5 cm. The tip of the spike is broken off. The sporangia are very numerous in the spike, some 35 being counted on the exposed surface. They are arranged in a close spiral and appear to be the same size throughout the spike. Those viewed abaxially show the typical reniform shape and the tangentially extended line of dehiscence.

In general characters the specimen agrees with the type material from the Centennial beds (Lang and Cookson 1930). It differs in the greater length of the spike and the more numerous sporangia in it. In spite of the fact that the distal portion is missing, the fertile region is at least 2 cm. longer than any specimen known from either Walhalla or Mount Pleasant. The sporangia themselves, though small (about 4 mm. across the widest part), are well within the limit for the species. The present specimen is distinctive for the unusually large number of sporangia that are crowded on the axis of the spike. Although the fertile spikes of *Zosterophyllum australianum* exhibit considerable variations, both in size of spike and the proportions and number of the individual sporangia comprising them, many more specimens will be necessary for comparison before specific distinctions are made.

3. *Incertae Sedis*

(a) Axes with H-shaped Branching

Plate VI, Fig. 23.

Several examples showing H-shaped branching have been found in the deposit near Yankee Jim Creek. The finest of these has been selected for illustration at a magnification of four diameters in Plate VI, Fig. 23. Its relatively main axis, about 1.5 mm. wide, shows two lateral branches which lie closely parallel to one another. The "upper" branch need not be considered further as only a short length of it is exposed. The "lower" appears to have divided by two successive dichotomies into two descending axes and one that was directed obliquely upwards. The descending limb (to the right in the photograph) shows further bifurcation into two more slender axes.

H-shaped branching was first observed in *Zosterophyllum myretonianum* where direct continuity with fertile axes clearly demonstrated it to be a feature of the rhizomatous regions of that plant. When similarly branched disconnected axes of between 1.5 and 2.5 mm. wide were found along with spikes and sporangia of *Z. australianum* at Mount Pleasant they were tentatively accepted and recorded as belonging to that species. The question of the future identification of disconnected branch systems of this type has been discussed by Croft and Lang (1942, p. 155). These authors remark that "evidence is, however, steadily accumulating that this type of branching was widespread among early plants." This being so, considerable caution should now be exercised before axes with H-shaped branching are accepted as evidence of the presence of *Zosterophyllum* in a deposit. Following the example set in this respect by Croft and Lang, the specimens from Yankee Jim Creek are recorded as *Incertae Sedis* rather than as vegetative branches of *Zosterophyllum australianum*.

(b) Pinnately-branched Axis

Plate VI, Fig. 24.

A few specimens from Mount Pleasant were grouped together under the heading "pinnately-branched axes." They are small portions of a new Siluro-Devonian plant, the nature of which has still to be discovered.

A single specimen of this rare type has been found near Yankee Jim Creek. The specimen, shown enlarged ten diameters in Fig. 24, though not as clearly defined nor as much branched as those from Mount Pleasant, is essentially of the same type of construction. It is a small curved axis about 1 cm. long and 0.75 mm.

broad. From the concave side of the axis three short branches arise, and it appears to terminate in a flattened, irregular expansion. The recurrence of this type links the beds under discussion with the sandstones of Mount Pleasant and encourages the hope that more connected specimens will ultimately be found.

(c) Stems with Small Spirally-arranged Elevations

Plate VI, Fig. 25.

A few short axes with small elevations on the surface or depressions (Plate VI, Fig. 25) on the corresponding counterparts have been found at this locality. These are suggestive of remains of small leaved stems, but no evidence of leaves or spines either at the margins or on the flattened surfaces has been seen. The specimens agree in every respect with similar remains described and figured from Mount Pleasant but like them can only be mentioned as a type of plant-remains and not as evidence of a small leaved plant in the Siluro-Devonian rocks of Victoria.

(d) Smooth Branched Axes

Plate VI, Fig. 26.

Small branched leafless axes are abundant in this deposit. All are indeterminate. The one shown in Plate VI, Fig. 26, however, has some comparative interest. It is a slender stem which just behind the point of bifurcation shows the base of an additional branch. Similar specimens were met with at the Centennial beds (Lang and Cookson 1930, Fig. 8) and at Mount Pleasant (Cookson 1935, Figs. 17, 18). They were recorded as *Hostimella* sp. and cf. *Hostimella* sp. respectively. At that time the resemblance to *Goslingia* (Heard 1927) was pointed out. Croft and Lang (1942, p. 143), in writing about similar axillary bodies in *Goslingia* from Llanover Quarry, Wales, stated that "it is useless at present to enter further into the general question of the nature of the axillary bodies which are now known to have been present in various early plants without being satisfactorily understood in any of them." The occurrence of this feature in several types of plant greatly reduces its usefulness as a diagnostic feature. It is therefore now suggested that the use of the name *Hostimella* sp. for branched leafless stems with axillary bodies be discontinued.

ACKNOWLEDGEMENTS

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EXPLANATION OF PLATES

All the figures are from untouched negatives. "C" before a specimen number refers to the Cookson collection.

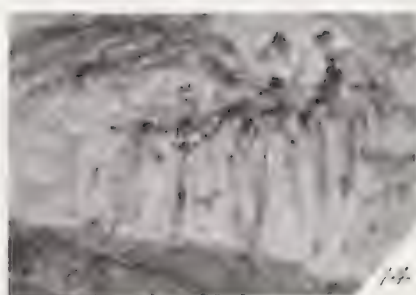
PLATE IV

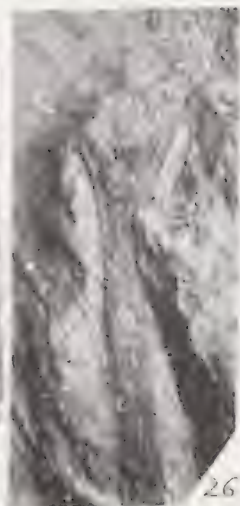
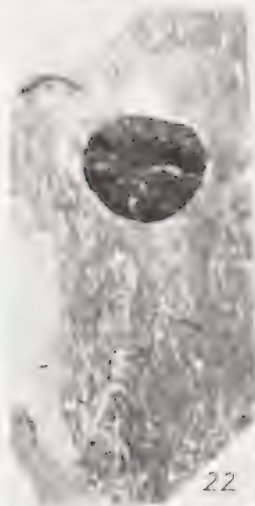
- Fig. 1. Cf. *Sporogonites*. Specimen showing general characters. Hull Road. $\times 10$. (C. 82.)
 Figs. 2, 3. Cf. *Sporogonites*. Specimen and its counterpart. Hull Road. $\times 10$. (C. 72, 72a.)
 Figs. 4, 5. *Yarravia* cf. *oblonga*. Specimen and counterpart of a fructification. Hull Road. $\times 4$. (C. 84, 84a.)
 Fig. 6. *Y.* cf. *oblonga*. Another fructification. Hull Road. $\times 4$. (C. 85.)
 Fig. 7. *Zosterophyllum australianum*. A detached sporangium showing marginal rim and stalk. Hull Road. $\times 4$. (C. 75.)
 Fig. 8. *Z. australianum*. Another specimen. Hull Road. $\times 4$. (C. 127.)
 Fig. 9. *Hedeia* cf. *corymbosa*. A corymbose branch-system. Hull Road. $\times 4$. (C. 44.)



Victorian Devonian Fossils.







- Fig. 10. *H. cf. corymbosa*. Lateral view of part of a branch-system showing two successive bifurcations at identical levels. Albert Hill Road, Lilydale. $\times 3$. (Nat. Mus. Vic., No. 14661.)
- Fig. 11. *H. cf. corymbosa*. Cross-sectional view of distal region of the same specimen. $\times 3$. Nat. Mus. Vic., No. 14662.)

PLATE V

- Fig. 12. *Hedeia cf. corymbosa*. Lateral view of a branch-system preserved in the solid. Hull Road. Natural size. (C. 102.) To be deposited in the Geological collection of the British Museum (Nat. Hist.).
- Fig. 13. *H. cf. corymbosa*. The same specimen. $\times 4$.
- Fig. 14. *H. cf. corymbosa*. Counterpart of the distal region of the above specimen. $\times 4$. (C. 102a.)
- Fig. 15. *H. cf. corymbosa*. A branch-system from Albert Hill Road, Lilydale. $\times 2$. (C. 106.)
- Fig. 16. *H. cf. corymbosa*. A specimen showing the branching of two secondary axes. $\times 3$. Albert Hill Road, Lilydale. (Nat. Mus. Vic., No. 14663.)
- Fig. 17. *H. cf. corymbosa*. A corymbose branch-system. $\times 3$. Syme's Homestead, Killara. (Nat. Mus. Vic., No. 14659.)
- Fig. 18. A smooth branched axis. Hull Road. $\times 4$. (C. 107.)
- Fig. 19. A small branched specimen. Hull Road. $\times 5\frac{1}{2}$. (C. 121.)
- Fig. 20. A smooth axis with a smaller lateral branch. Hull Road. $\times 4$. (C. 120.)

PLATE VI

All specimens are from Warburton-Wood's Point Road, near Yankee Jim Creek.

- Fig. 21. *Zosterophyllum australianum*. A fertile spike. Natural size. (Geol. Surv. Vic., No. 47387.)
- Fig. 22. *Pachytheca* sp. Specimen showing differentiation into medulla and cortex. $\times 3$. (C. 128.)
- Fig. 23. Specimen showing H-shaped branching. $\times 4$. (C. 129.)
- Fig. 24. A pinnately branched axis. $\times 10$. (C. 145.)
- Fig. 25. Stem showing small concavities. $\times 2$. (C. 59.)
- Fig. 26. A branched axis showing the base of a third branch. $\times 2$. (C. 148.)

